SOVIET CORRELATION OF FORCES AND MEANS: QUANTIFYING MODERN OPERATIONS

A thesis presented to the Faculty of the U. S. Army Command and General Staff College in partial fulfillment of the requirements for the degree

Master of Military Art and Science

by

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This study analyzes the nature and extent of use of the Correlation of Forces and Means (COFM) in Soviet operational and tactical decision-making. It discusses the historical and military-scientific forces that compel the Soviets to use mathematical methods for solving complex battlefield problems. It details the methodology through which the Soviets likely arrive at combat potentials for armament and how these potentials are aggregated for force comparisons. It reviews the relationship between force correlations and Soviet mathematical models and describes how both are used to support the operational commander's decision. The study concludes with an analysis of the strengths and weaknesses of the COFM methodology. The author finds that COFM is an effective force optimizer that also relieves the commander of many burdensome assessments during his decision process. However, COFM was also found to suffer distinct limitations and weaknesses. Chief among these was its inability to quantify many of the more important battlefield variables that affect modern combat and operations.

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The opinions and conclusions expressed herein are those of the student author and do not necessarily represent the views of the U.S. Army Command and General Staff College or any other governmental agency. (References to this study should include the foregoing statement.)

ABSTRACT

SOVIET CORRELATION OF FORCES AND MEANS: QUANTIFYING MODERN OPERATIONS, by Major James K. Womack, USA, 126 pages.

This study analyzes the nature and extent of use of the Correlation of Forces and Means (COFM) in Soviet operational and tactical decisionmaking. It discusses the historical and military-scientific forces that compel the Soviets to use mathematical methods for solving complex battlefield problems. It details the methodology through which the Soviets arrive at combat potentials for armament and how these potentials are aggregated for force correlations. It reviews the relationship between force correlations and Soviet mathematical models and describes how both are used to support the commander's operational decision.

The study concludes with an analysis of the strengths and weaknesses of the COFM methodology. The author finds that COFM is an effective force optimizer that also relieves the commander of many burdensome assessments during his decision process. However, COFM was also found to suffer distinct limitations and weaknesses. Chief among these was its inability to quantify many of the more important battlefield variables that significantly influence the course and outcome of modern combat and operations.

Among the author's recommended areas for further research is the evaluation of a COFM-like methodology for U.S. Army use in the field.

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Any omissions, errors in interpretation, or analytical oversights in this thesis are singularly attributable to the author.

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INTRODUCTION

> ***Any kind of planning is unsound, if it is not supported by scientific foreknowledge of the possible course of operations, the forms and methods of armed struggle, with the help of which are achieved the objectives put before the troops.*[1]**
>
> ***Marshal of the Soviet Union G. K. Zhukov***

BACKGROUND.

The Soviet penchant for objectivity and optimization in military affairs has only recently become an area of distinct concern to Western defense establishments: perhaps because of Soviet overtures in the arms control arena; perhaps because of political pressures to reduce Western defense expenditures; or perhaps because of genuine interest in understanding the Soviets' scientific approach to preparing for and waging modern war. Quite possibly, it's a combination of all three. Regardless, the nature of Soviet military science is attracting significant attention of late, and serious Western studies are turning up some interesting revelations.

One of the more intriguing areas of study is Soviet military forecasting. In his insightful study of the evolution of Soviet foresight and forecasting, Dr Jacob Kipp discloses the Marxist-Leninist underpinnings for and the dialectical-materialist nature of Soviet military forecasting. He carefully constructs an historical lineage of contemporary military forecasting from its origins in the military circles of tsarist Russia. He reveals the early contributions of such key figures as Chebyshev, Volotsky, and Osipov in establishing a fundamental, mathematical basis for analyzing the course and outcomes of war. He then traces the development of forecasting in Soviet military science from the early

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[1]P. K. Althukov, *Basis of the Theory of Troop Control*, (Moscow: Military Publishing House), 1984. English Translation, p. 128.

Twentieth Century, through the difficult Stalin years, into the (present) era of the "Cybernetic Revolution." Dr Kipp's treatise clearly establishes that contemporary Soviet forecasting is ***not*** the result of some recent Soviet ideological change; rather, that it represents the synthesis of over a century of professional military and scientific thought.[2]

Soviet theorists have openly been developing mathematical solutions for military forecasting problems since at least the late 1800's. Over the course of the last 100 years they have developed quantitative methods for forecasting battle outcomes, identifying lucrative force development opportunities, and even anticipating the probable developments in the armaments of their enemies. By the late 1950's, Soviet military scientists had begun deriving a variety and multiplicity of combat models which could be used for optimizing courses of action, predicting the relative rates of advance on the battlefield, and otherwise assisting the commander with his troop control process. These models were fitted, where appropriate, to the outcomes of Soviet operations and battles in the Great Patriotic War. Because they were constructed from the well known laws of mathematics, the Soviets considered their methodologies to be dialectically and scientifically sound, consistent with Marxist-Leninist teachings.

By the early 1960's, the mathematics of armed conflict was categorized as a branch of Soviet operations research (OR)-- the special science that rationally organizes goal-directed human activity.[3] It appears that original Soviet OR *theory* borrowed heavily from Western works; specifically, from their 1950's consumption of N. Wiener's ***Cybernetics or Control and Communications in the Animal World and in Machines*** and Morse and Kimball's ***Methods of Operations Research.***[4] However, their

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[2]Jacob W. Kipp, *From Foresight to Forecasting: The Russian and Soviet Military Experience*, (College Station, TX: Center for Strategic Technology), 1988, pp. iii-273.
[3]Ye. S. Venttsel', *Introduction to Operations Research*, (Moscow: Soviet Radio Publishing House), 1964, p. 1.
[4]Kipp, pp. 177-179.

applications of OR theory to the problems of operational and tactical decision-making were unique. One such application was the correlation of forces and means (COFM). The Soviet ***Dictionary of Military Terms*** defines correlation of forces and means as

> an objective indicator of combat might/power of opposing sides which makes it possible to determine the degree of superiority of one side over another. This is determined by means of comparing the quantitative and qualitative characteristics of subunits, units, and formations and the armaments of one's own troops (forces) and those of the enemy.[5]

Recent Soviet articles in the periodical ***Voyennaia mysl'*** reflect new insights into the Soviet quest for objectivity and optimization through use of the COFM methodology. In its simplest form, COFM uses purely objective armament and unit combat potentials to mathematically compare the aggregate strengths of opposing combatants. The COFM methodology is not, however, limited to simple "static" force comparisons. The Soviets have developed sophisticated mathematical models which can ascertain "dynamic" and "kinematic" correlations-- taking time and temporal characteristics of the battlefield into account. In short, COFM is an objective means for analyzing many (if not most) aspects of modern warfare. It has become a preferred tool for assisting Soviet commanders in making operational and tactical decisions.

PURPOSE.

The purpose of this thesis is to describe how the Soviet COFM methodolcgy is applied in Soviet operational and tactical decisionmaking. To accomplish this task, the author will first examine historical and contemporary Soviet inclinations for use of objective, mathematical methods in military problem-solving. Having established the lineage of COFM, the author will then examine the constituent elements of the COFM methodology-- the Soviet approach to quantifying the battlefield. Next will follow the contextual

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[5] "Correlation of forces and means," *Soviet Dictionary of Military Terms*, (Moscow: Military Publishing House), 1988, p. 255.

relationship of COFM and Soviet military decisionmaking at the operational and tactical levels of military art. The author will discuss how COFM assists the commander in making (or otherwise substantiating) optimal decisions. The thesis will culminate with an analysis of the key strengths and weaknesses of the COFM methodology.

ASSUMPTIONS.

The principal premise of this effort is that the Soviet commanders actually use mathematical methods-- specifically the COFM approach --in operational and tactical decisionmaking. Given the variety of supporting source material, this assumption appears sound. A key underlying assumption is that the preponderance of published Soviet work on this subject is not the product of some broad disinformation campaign. The author's background reading on the topic (both classified and unclassified U.S. holdings) supports this assumption. It is hardly logical (or practical) for the Soviets to distribute hundreds of documents among thousands of professional (Soviet) military officers which convey misleading information about the methods for conducting troop control. Considering the extensive addressment the Soviets have given COFM over the past two decades, the multiplicity of sources in which COFM is found, and the consistency with which COFM is treated in the source material, it is readily apparent that COFM is an important element of Soviet troop control.

DEFINITIONS AND TERMINOLOGY.

Because Soviet military art and science have different taxonomical relationships than their Western corollaries, the author will distinguish Soviet military terminology from Western terminology, where appropriate. The author has defined a number of technical and tactical terms in Appendix 1 for this thesis. Further, the author has compiled several listings of Soviet laws, law-governed patterns, and principles relating to war and armed conflict, which may be found in Appendix 2.

The Soviets are careful to distinguish their military lexicon from that of the "bourgeois" states. To avoid confusing Soviet and Western (particularly U.S.) terminology the reader is urged to review Appendices 1 and 2 for the preferred Soviet usage. Two key terms not discussed in the appendices, but used throughout this thesis in describing unit sizes, are the terms "operational" and "tactical." All references to "operational forces" and "operations" refer to the force groupings and activities of Soviet Fronts and Armies. The term "tactical" applies to formations, units, and sub-units (Division and below). The term "operational-tactical" is used to describe forms and methods that are common to both levels of military art. For sake of brevity, the author will frequently use parenthetical references to indicate COFM applications at varying levels of military art. More specifically, "combat (operations)" and "operations (combat action)" are Soviet terms used by the author to convey principal significance at tactical and operational level, respectively, but having general applicability at both levels of military art.

SCOPE, LIMITATIONS, AND DELIMITATIONS OF THE STUDY.

The scope of this thesis is focused on the application of the COFM methodology at the Soviet operational level of warfare. The author develops Soviet division-level manifestations of the COFM methodology so that its tactical context may be comprehended. And, some discussion will surround COFM's potential for use in arms control. However, the most prevalent and important uses of COFM are in support of front and army level decisionmaking, so this paper principally deals with its operational-level implications.

This thesis will not attempt to explain or analyze the applications of the COFM methodology in all areas of Soviet military science. The scope of the effort has been limited to COFM derivations using conventional battlefield weapons. Some discussion (in Chapter 5) will outline COFM's limited application in considering the traditional "weapons of mass destruction." But, there is insufficient "open literature" to warrant a serious, unclassified treatment of COFM in an environment of nuclear, biological, and chemical weapons. This omission should not detract from the quality or usefulness of the final product.

The two general focuses of the author's attention of COFM are: (a) discussion of ***ground*** forces (both armament and force potentials); and (2) COFM in its mid- to high-intensity context. There is insufficient unclassified information on air and naval contributions to COFM for them to be similarly treated in this study. Further, the author has purposefully limited this effort to a discussion of COFM as it would be used in the event of conventional war between similarly equipped combatants (the Soviet Union and a modern Western nation, for example). These restrictions helped to narrow the endeavor to a more manageable and understandable product.

A final restriction of this thesis pertains to its level of classification. Because so many of the ***practical applications*** of Soviet military science remain classified, both in the U.S.S.R. and in the U.S., certain key elements of Soviet use of COFM techniques are unavailable for Western consumption.

SIGNIFICANCE OF THE STUDY.

The author believes this paper to be the first comprehensive Western synthesis of literature pertaining to Soviet use of COFM for operational and tactical decisionmaking. There exist a number of excellent Western references describing the nature of Soviet troop control, Soviet military science, and Soviet operational art. However, the author's survey of classified and unclassified U.S. literature revealed no studies conveying adequate treatment of mathematics and mathematical modeling in the Soviet troop control process. This paper should help remedy that deficiency. At the very least, it will unveil the role that COFM plays in the Soviet development of "decision variants" and in substantiating their operational-level commanders' decisions.

A concerted effort has been made to describe COFM applications in (military) laymen's terms. The author explains Soviet models, equations, and principles so they may be understood by readers who have a fundamental appreciation for probability theory and statistical methods. Intended for the Defense Technical Information Center database, this thesis would be a valuable reference for DoD (Department of Defense) intelligence analysts and decisionmakers. Last, this thesis may provide incentive for U.S. combat developers to adapt a similar methodology for use in the field. Currently, U.S. techniques and procedures do not require the use of quantitative methods for operational and tactical decisionmaking.

AUTHOR'S BACKGROUND.

The author worked directly on Soviet military topics while assigned to the Office of the Deputy Chief of Staff for Intelligence, U.S. Army, from 1987-1989. He has maintained direct contact with DoD officials working with the latest Soviet information on the subjects of troop control and the COFM methodology. The author is thoroughly familiar with the U.S. Army's ***Soviet Battlefield Development Plan*** and has been the Army's senior reviewer for Army Intelligence Agency technical publications on Soviet close combat force capabilities. He has prepared over one-hundred government papers and memoranda on Soviet close combat forces-- principally on tactical and technical developments for current and future motorized and tank forces.

LITERATURE REVIEW.

The selected bibliography for this thesis contains some seventy-plus references that pertain to the author's purpose and scope. These sources provided sufficient information to construct an analysis of the COFM methodology, but were by no means exhaustive in their treatment of the topic. A number of "gaps" exist in unclassified Western holdings about the latest weapons coefficients used in Soviet databases and the specific capabilities of the computer equipment used in the Soviet automated troop control complex. Chapter 6 (Conclusions and Areas for Further Research) addresses this problem in more detail.

A query of the Defense Technical Information Center and National Technical Information Service databases yielded only a few documents on the COFM subject, but a substantial number of related Soviet publications (cybernetics, military models and modeling, forecasting, OR applications, etc.) were found and acquired. Similarly, there were a number of available Joint Publications Research Service and other U.S. Government translations (from Soviet writings) on COFM-related topics. Several useful Western publications have been found. In particular, analyses of Soviet Military OR by Dr Allan Rehm were of great use.

Principal references used for establishing the relationship of COFM to Soviet troop control theory and practice are Altukhov's ***Basis of the Theory of Troop Control,*** Savkin's ***Basic Principles of Operational Art and Tactics***, Chuyev's ***Forecasting in Military Affairs***, Kipp's ***From Foresight to Forecasting: The Russian and Soviet Military Experience***, and Lomov's ***Scientific-Technical Progress and the Revolution in Military Affairs.*** These sources were particularly helpful in revealing the Soviet preoccupation with automation in the troop control process. Their discussions of the laws and general principles of armed conflict, the roles and responsibilities of the commander and staff in making combat decisions, and the roles of foresight and forecasting on the modern battlefield rank among the finest in contemporary military literature. They give a unique, Soviet perspective to contemporary warfare and the imperative for automating the decisionmaking and control processes.

Perhaps the most significant of the author's source material was the collection of articles published in the periodical ***Voyennaia mysl'*** between 1976 and 1988. Apparently published for a "restricted" audience, these seminal documents have only recently begun to appear in the West. They develop a lengthy discourse on the various methods for achieving objectivity when making quantitative comparisons of opposing combatants. They reflect an ongoing internal debate among Soviet theorists as to the most appropriate techniques for deriving combat potentials (for both weapons and means) and modeling modern operations. Insights gained from these documents were critical to establishing the framework for Chapter 3 (The Mechanics of COFM) of this thesis .

The author acquired several Soviet publications, dating from the mid-1960's through the early 1980's, related to military mathematics. Especially useful were Venttsel's ***Introduction to Operations Research***, Tkachenko's ***Mathematical Models of Combat***, Tarakanov's ***Mathematics and Armed Combat***, and Vayner's second edition of ***Tactical Calculations.*** These books revealed the extent and nature of use of mathematical theory in many forms of combat, combat support, and combat service support activities on the battlefield. They demonstrate that there is virtually no area of Soviet military affairs in which mathematics fails to have a function. From these references the author was able to identify some of the principal equations and models through which COFM is applied.

The balance of references in the author's bibliography contribute in one way or another to the historical Soviet quest for objectivity and optimization in the management of armed conflict, to the analysis of COFM's strengths and weaknesses, or to the nature of the Soviet troop control process.

CHAPTER 2

WHY COFM ?

***There is no 'forbidden' zone in military affairs in which quantitative analysis would be unacceptable.*[1]**

A. Ya. Vayner

COFM'S NICHE IN SOVIET MILITARY AFFAIRS.

To fully comprehend the nature and extent of use of the correlation and means (COFM) methodology in Soviet military affairs, one must first understand the nature of Soviet military science and its manifestations. This necessitates, first, a review of the essential elements of Soviet military science which provide the impetus for mathematical methods. Further insight may be gained through analysis of the historical Soviet predilection for mathematical approaches to complex, military-scientific problems. The last few decades, in particular, have witnessed the emergence of Soviet military operations research and cybernetics. These developmental patterns led naturally to greater use and acceptance of objective methods, thus securing COFM's place in the fundamental tenets of Soviet military laws, law-governed patterns, and principles. Indeed, recent Soviet writings about the nature of the modern battlefield seem to echo the call for continued use (and refinement) of COFM methods.

SOVIET MILITARY SCIENCE.

Contemporary Soviet military science comprises a rigorous system of analysis and classification for all aspects of military affairs. It prescribes a research methodology that includes the study of actual military operations,

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[1]A. Ya. Vayner, *Tactical Calculations*, 2d ed., rev. and supp., (Moscow: Voyennoye Izdatel'stvo), 1982. Translated by U. S. Air Force (FTD-ID(RS)T-1501-84), (AD-B091870), 21 March 1985, p. 7.

previous wars, peacetime activities, range testing, experimental exercises, command post exercises, scientific-research games, comparison and analogy, analysis, and abstraction.[2] The Soviets do not deny the existence of military "art" but, rather, they subordinate military art to the broader contextual scope of military science.[3] Thus, Soviet military science comprises the all-encompassing study of armed conflict.

The scientific nature of the Soviet approach to the study of armed conflict is grounded in Marxist-Leninist principles-- specifically, that each science is a "separate form of social awareness" containing its own system of laws, concepts, and theories which are unified by ideas and logic.[4] However, the Soviets also believe there is a fundamental interconnection among the pure, natural, and applied sciences (mathematics, physics, biology, etc.) and military science. It follows, then, that their military scientists would approach the study of armed warfare much the same way Soviet mathematicians approach their craft. Their quest is to reduce the phenomena of armed conflict to perceptible, objective tools that may be used to successfully prepare their armed forces for modern armed conflict.

MATHEMATICS AND SOVIET MILITARY SCIENCE

History reveals a significant interaction between mathematical theory and the evolution of Soviet military science. As early as the latter half of the 19th Century, mathematical concepts were used in military problem-solving. Beginning in the 1850's military wargames employing rudimentary mathematics were officially introduced for training the Tsar's general staff officers. And, by 1884, Nikolai Volotsky directly applied mathematical means (including

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[2]N. A. Lomov, et al., *Scientific-Technical Progress and the Revolution in Military Affairs*, (Moscow: Military Publishing House), 1973. Translated by the U.S. Air Force, (Washington, D.C.: U. S. Government Printing Office), pp. 241-243.

[3]A. M. Plekhov, "Military Art," *Dictionary of Military Terminology*, (Moscow: Military Publishing House), 1988, p. 51. [See Appendix 1 for current Soviet definitions of Military Art and Military Science.]

[4]Lomov, p. 12.

probability theory) for solving wartime ammunition supply problems. Even a future war minister, D.A. Miliutin, became a proponent for the use of statistics for military problem-solving; in effect, signalling high level acceptance of mathematical theory and application in Soviet military affairs.[5]

Despite certain difficulties in generating universal acceptance of military-scientific theory, mathematical applications to complex military problems began to flourish in the early 20th Century. In 1903, Volotsky expanded the application of probability theory to various areas of combat logistics; although his published manuscripts would arrive too late to favorably influence the outcome of the Russo-Japanese War of 1904.[6] A particularly far-sighted treatise by A. A. Bogdanov, in 1913, outlined a theory of tectology (the integrated science of control), which might well be referred to as the apocalyptic forerunner of late 20th Century Soviet cybernetics.[7]

By the outbreak of World War I, prominent military and civilian writers were mathematizing the theories of modern combat. Of particular significance were the contributions of N. Osipov, who, independent of F.W. Lanchester, derived a series of finite difference equations for predicting combat outcomes. He developed his "theory of losses" from an analysis of 38 historical battles between 1805 and 1905.[8] Although simplistic in their treatment of the factors contributing to battle losses, Osipov's formulae were a excellent starting point for future application in forecasting battle outcomes and in optimizing the employment of one's forces. This remarkable work by Osipov served as historical substantiation of the interrelationship of mathematics and armed conflict. Several decades later the Soviets would expand and refine his basic equations to include the consideration of randomness and battlefield variables.

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[5]Jacob W. Kipp, *From Foresight to Forecasting: The Russian and Soviet Military Experience,* (College Station, TX: Center for Strategic Technology), 1988, pp. 18-19.

[6]Ibid., p. 29.

[7]Ibid., pp. 87-89.

[8]Allan S. Rehm, "Soviet Models of Warfare," Paper presented at the Second Calloway Gardens Proceedings: *Simulations of Warfare and Gaming,* Georgia Tech University, 1984, p. 204.

It was during the World War I years that another prominent military professional, P. Izmest'ev, presented the imperative for exercising military foresight in the preparation of war plans. Kipp cites Izmest'ev's criticisms in the military professional journal ***Voennyi sbornik*** of 1916, as arguing:

> that "doing one's sums" in the fashion of the great captains no longer would suffice. As war had become more complex, involving more men, higher densities of firepower and more sophisticated means of command and control, the need arose for the commander and staff to have available means that would improve calculations of battle and thereby reduce the element of risk.[9]

Izmest'ev was an early champion of foresight in the development of plans at the strategic level. He acknowledged the interference of "friction" in the actual execution of these plans but felt that any well-contrived plan-- particularly one in which the requisite mathematical calculations had been made --could enhance the probability of success at any level of fighting.[10] Forecasting, the product of sound military thinking (or foresight) and objective (mathematical) calculations, was fast becoming a principal tenet of Russian military science.

V. I. Lenin's predilection for the dialectical materialist principles of objectiveness, regularities in nature and society, and the possibilities of knowledge strongly influenced the post-1917 development of Soviet military theory. Lenin's philosophical views were compatible with the General Staff's pre-Civil War inclinations toward more objective, scientific methods in military affairs and towards the development of military foresight. Indeed, former tsarist officers such as V. P. Triandafillov and M. N. Tukhachevsky emerged as a proponents of Leninist theory as they sought to unify the relationship of Marxist-Leninist principles with the still formative Soviet military science in the 1920's and 1930's.[11]

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[9]Kipp, pp. 38-39.
[10]Ibid., pp. 40-41.
[11]Ibid., p. 82.

Virtually every aspect of military affairs would be touched by Lenin's ideological basis. V. V. Kuibyshev would apply scientific methods to the Soviet system for records management so that recent combat experiences could be more readily accessible for scientific research. Alexei Gastev developed applications for the scientific organization of Soviet labor, which impacted directly on the production of combat materiel in the factories and on troop labor in the various military organizations. I. I. Gludin found scientific applications for improving the control processes of military organizations. His measures for reducing bureaucracy and cumbersome formalities were to have positive effects on military decision-making, on troop training and on Soviet preparations for war.[12]

During this same period, mathematical methods continued to improve and to find applications in the emerging Soviet military science. Of particular note was A. N. Kolmogorov's work in probability theory which outlined the general principles for the evaluation of the effectiveness of firing systems. P. P. Khandozhko applied this work as early as 1926 to his development of a theoretical model for air combat. In 1934, A. N. Lapchinsky published his first in a series of three volumes of theory on air power. Imbedded in his doctrinal treatises were Kolmogorov's probability models. Both Khandozhko and Lapchinsky's works would directly influence the development of aviation support of Soviet ground forces throughout the Great Patriotic War.[13]

Soviet military science suffered during the difficult and oppressive Stalin years. Testimony to this were the crippling purges which claimed the lives of such prominent military figures as Tukhachevsky. Still thousands of others were imprisoned, leading to an enormous loss of creative development. The noted Russian cyberneticist, A. I. Berg was one such detainee. He recalled the nature of this repressive period in Soviet military history:

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[12]Ibid., pp. 91-96.
[13]Ibid., pp. 142-145.

> Thereafter there came difficult times: 1937, the loss of one's close friends. Soon I too was arrested on the basis of a ridiculous and stupid denunciation. I spent precisely 900 days in prison. I was let out shortly before the war. During these years radio-technology suffered an enormous loss. Institutes and laboratories were closed down and people disappeared.[14]

Despite the multitude of lessons learned (including some positive experiences in COFM application) in WWII, military-scientific research would not enjoy a progressive, dialectical atmosphere until the death of Stalin and the dissolution of his "secret chancellery."

THE EMERGENCE OF SOVIET OPERATIONS RESEARCH

The mid-1950's witnessed a sharp increase in intellectual exchanges relating to the future of Soviet military science. A number of technical and operational developments were borne out of this period. Perhaps most significant was the development and application of operations research techniques to military operations. The early cybernetics work of Berg and Kantorovich, although suppressed in the Stalin years, found wide-spread acclaim in the late 1950's and early 1960's; especially after parallel Western efforts gained acceptance in the U.S.S.R. Of particular influence was the circulation of Morse and Kimball's ***Methods of Operations Research*** and N. Wiener's ***Cybernetics or Control and Communications in the Animal World and in Machines***.[15] No doubt, these books helped to fuel the assimilation of advanced, operations research (OR) techniques throughout the military. Soviet theorists embraced cybernetics, now an officially-sanctioned science of control, for its potential in defense-related tasks.

Soviet military applications of operations research techniques and mathematical theory have grown virtually unabated since the early 1960's. In 1964, Ye. S. Venttsel' published her first volume of ***Introduction to Operations Research*** (which, by the way, is still used in the classrooms of

[14] Ibid., p. 140.
[15] Ibid., pp. 177-179.

U.S. military institutions since no comparable Western text has yet been produced).[16] Venttsel's work was evidence of early Soviet recognition of the usefulness of OR in solving tactical and technical military problems. Although, according to Venttsel', Soviet OR was broadly applicable to all areas of goal-directed human activity, the focus of her work was almost entirely directed toward military-technical problem-solving.

According to Kipp, by the mid-1960's the Soviet military was fully committed to the use of military cybernetics and OR.[17] Indeed, OR methods found popular appeal in all areas of forecasting. Beginning in the late 1960's, Soviet authors presented a variety of applications where mathematical-cybernetic support could aid decisionmaking. A majority of the authoritative military publications following this period stressed the benefits to be derived from automated systems of control, the role of forecasting in the decision process, and the importance of optimizing resources-- in particular, time --in the conduct of military operations. Imbedded mathematical techniques which found application included probability theory, quaueing theory, game theory, and linear programming.

CONTEMPORARY SOVIET MILITARY OR

During the 1970's and 1980's, the Soviets published a number of books and papers pertaining to forecasting, decisionmaking, automation of control, and other OR-related topics. These works reflected a common theme of a growing acceptance of OR methods into all areas of military affairs, even despite an apparent technological gap between the capabilities of Soviet automation and the needs of the military. Soviet military science fully embraced the automation of their troop control complexes and made forecasting an instrumental part of the military decisionmaking process. References that best convey the nature and extent of these influences include: Chuyev and

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[16] Ye. S. Venttsel', *Introduction to Operations Research*, (Moscow: Sovetskoe Radio), 1964. English Translation, p. i.
[17] Kipp, p. 185.

Mikhaylov's ***Forecasting in Military Affairs*** (1975), Lomov's ***Scientific-Technical Progress and the Revolution in Military Affairs*** (1973), Savkin's ***The Basic Principles of Operational Art and Tactics*** (1972), Druzhinin's ***Concept, Algorithm, Decision*** (1972), Altukhov's ***Basis of the Theory of Troop Control*** (1984), and Ivanov's ***Fundamentals of Tactical Command and Control*** (1977).

The insatiable Soviet quest for objectivity and optimization appear to have been significant forces for increased automation of control and expanded emphasis on military forecasting. As stated by General of the Army V. G. Kulikov, in 1973:

> Under present-day conditions, the danger of miscalculations and errors in decisions has increased. There is now a need for more profound foresight, more scientific forecasting of the possible course of combat operations, and more accurate calculations of the anticipated results. The timeliness of decision-making and maximum reduction of the time taken to plan, formulate, and organize the execution of missions have become matters of great moment.[18]

Clearly, contemporary Soviet military thought has come to place a high premium on foresight and forecasting in the preparation and conduct of military operations. And, according to Chuyev, mathematical methods facilitate the selection of the most correct variants of decisions during both the planning and execution phases of these operations.[19] In its essence, then, forecasting became the means (objective or mathematical processing) to an ends (verification of the optimal course of action or decision variant).

It is precisely their emphasis on forecasting that makes the correlation of forces and means (COFM) such an important part of Soviet military affairs, today. The objective quantification and mathematical comparison of opposing

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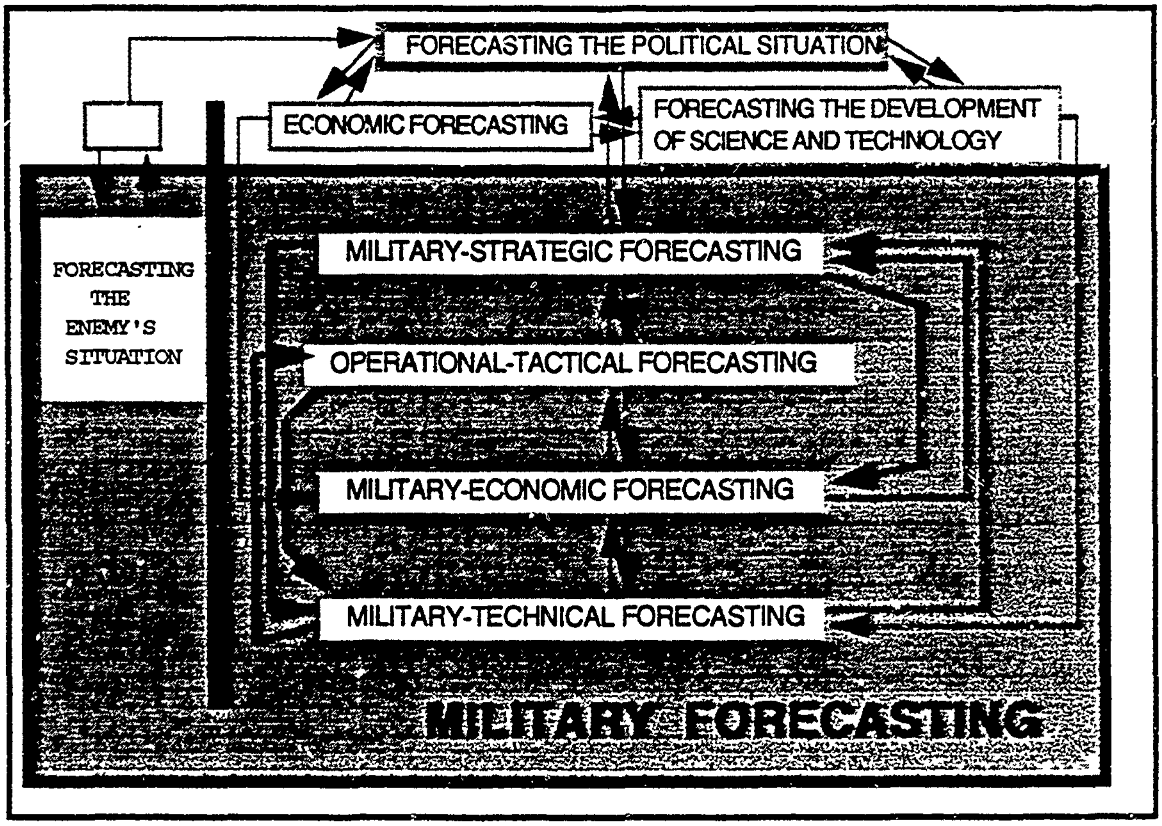
[18]Yu. V. Chuyev and Yu. B. Mikhaylov, *Forecasting in Military Affairs*, (Moscow: Military Publishing House), 1975. Translated by the Translation Bureau, Secretary of State Department, Ottawa, Canada, (Washington, D. C.: U. S. Government Printing Office), p. 1.
[19]Chuyev, p. 2.

forces (and their means of employment) leads to foreknowledge of the combat outcomes. The theoretical implications are enormous. One could forecast the resolution of operational- and strategic-level encounters as well as homogeneous, small unit combat. Moreover, given sufficient information on the principal directions of materiel, combat, and force developments of one's adversaries, one's own (future) requirements in these areas may be forecast. COFM could be used as the comparative tool. (Figure 1 illustrates the variety of contemporary Soviet forecasting used to satisfy military requirements.)



[FIGURE 1][20]

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[20]Ibid., p. 18.

SOVIET LAWS, LAW-GOVERNED PATTERNS, AND PRINCIPLES

Given the Soviets' tendency towards a ***scientific*** study of armed warfare, it is appropriate to examine their classification system for laws, law-governed patterns, and principles for further insight into the nature of COFM. (Appendix 2 catalogues but a few of the more important ones related to this thesis.) After all, the principal research tools of any mathematical scientist are his accepted theoretical laws, theorems, and corollaries.

Now, Soviet military science does not seek to study the "laws of war," per se, because of war's broad contextual basis. Rather, Soviet military scientists address themselves to the laws wholly within the scope of their concerns-- notably, the laws of ***armed*** warfare or struggle. [Note: different Soviet texts cite slight variations in the titles of these laws and their constituent elements. See Appendix 2.] Soviet theoreticians believe them to be immutable and unchanging over time-- much the same way that Western military theorists view their "principles of war." Soviet laws of armed warfare or struggle interrelate universal objective and subjective influences in the study of armed conflict so that necessary and stable ties among war's phenomena may be understood.[21] These ties are thought to be independent of the will of man or to changing socio-economic, political, and material conditions.

The Soviets' fourth law of armed struggle is "the dependence of the course and outcome of armed struggle on the ***correlation of forces and means*** of the parties." The other five laws are closely interrelated.[22] The fact that COFM is embodied in a ***law*** is testimony to its significance in Soviet military science. Because it is a ***law*** of armed struggle, favorable COFM outcomes must continuously be sought to assure the desired course and

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[21]K. V. Tarakanov, *Mathematics and Armed Combat*, (Moscow: Military Publishing House), 1974. Translated by U.S. Air Force (FTD-ID(RS)T-0577-79), (AD-B043718), 15 August 1979, p. 10.

[22]P. K. Althukov, *Basis of the Theory of Troop Control*, (Moscow: Military Publishing House), 1984. English Translation, p. 28.

outcome of armed struggle. Strategic manifestations of this law are the incredible force levels-- conventional, unconventional, and strategic -- maintained by the Soviet Union over the past four decades. These forces have been necessary, in the Soviet mentality, to correlate favorably with those of potential adversaries and their probable coalitions.

The next hierarchical order in Soviet military science are the important law-governed patterns of armed combat. They differ from their parent laws principally in their more explicit manifestations in the phenomena of armed conflict. As cited in Appendix 2, the fifth and sixth law-governed patterns are "the dependence of the course and outcome of armed combat on weapons and combat potential, and on the presence of superiority over the enemy in forces and means at decisive places and times."[23] Together, these law-governed patterns embody the essence of COFM-- that the outcome of armed combat is both: (a) a function of the materiel and its means of employment; and (b) the establishment of a favorable ***correlation of forces and means*** at decisive points on the battlefield (or at sea, or in the air, or in space).

Important here are the operative words ***decisive places and times.*** It is ***not*** necessary to outnumber the enemy in forces and means continuously throughout the battlefield. Rather, the imperative is to determine the ***decisive*** moments and locations for massing men, materiel, and fires.

Next in the taxonomic classification are Soviet principles. The Soviet conception is that these operating tenets are ***not*** immutable or unchanging. Rather, they are considered as the "basic ideas and most important recommendations for the organization and conduct of a battle, an operation, or a war as a whole."[24] As such they are not considered to be reducible to ordinary rules, norms, or theses. Among the principles of operational art and tactics is the "concentration of main efforts and creation of the necessary

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[23]Tarakanov, p. 12.

[24]V. Ye. Savkin, *The Basic Principles of Operational Art and Tactics*, (Moscow: Military Publishing House), 1972. Translated by the U.S. Air Force, (Washington, D. C.: U.S. Government Printing Office), 1974, p. 119.

superiority in men and weapons over the enemy at the decisive place at the decisive time."[25] This principle is meant to infer the necessity for concentrating a favorable ***correlation of forces and means*** on the main axes during armed combat.[26] Again, COFM's presence is underscored.

So, all three hierarchical levels-- laws, law-governed patterns, and principles --contain direct or indirect references to the correlation of forces and means and its theoretical relationship to the course and outcome of armed struggle or combat. But how does modern all-arms warfare influence the need for the COFM methodology? More specifically, in what ways have the so-called "revolution in military affairs" and the "revolution in military technology" compelled the Soviets toward practical COFM applications? The answers to these questions should establish the necessary foundation for subsequent investigation into the current COFM methodology.

THE MODERN BATTLEFIELD

The last four decades have witnessed historically unprecedented changes in military affairs. Virtually every aspect of the modern battlefield has been affected in some way by the development of vastly more sophisticated weapons and their means of employment. The highly proliferated and traditional weapons of mass destruction (WMD)-- nuclear warheads, chemical agents, and biological weapons --have nearly been matched in destructive power by emerging conventional weapons, but without the moral stigma normally associated with the use of the WMD. Among the more celebrated of these new weapons and means are long-range precision-guided munitions (both artillery and rocket delivered), reconnaissance-fire and -strike complexes, advanced tactical and fighter aircraft carrying "smart" weapons, and sophisticated combat helicopters carrying large missile payloads.[27]

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[25]Ibid., p. 214.
[26]Ibid., p. 229.
[27]V. G. Reznichenko et al., *Taktika*, (Moscow: Military Publishing House), 1987. Translated by Joint Publications Research Service (JPRS-UMA-88-008-L-I), 29 June 1988, pp. 6-14, 32.

The Soviets believe this rapid rate of technological innovation among emerging weapons and their means of control has radically altered the nature of modern, all-arms warfare-- to include increasing its tempo, depth, and potential lethality.[28] These modern forces and means bear further examination.

MODERN FORCES AND MEANS

Reznichenko ably describes the effects that contemporary battlefield weapons are having on the methods and forms of tactical combat and operational art. Citing the possibility that modern operations may be conducted with or without nuclear weapons, he details the contributions of the variety of forms and means to the battlefield's increasing fluidity and dynamism.[29]

Nuclear weapons, particularly the more recent neutron variants, are still regarded as the most devastating and influential means for rapid annihilation of the enemy. Reznichenko reports that the numbers and ranges of these weapons have doubled over the past 10 or so years, while their delivery accuracy has increased by three- or four-fold. Whereas, in World War II, it would have taken up to 100 guns and mortars firing 15-20 minutes to suppress a prepared company defense, a single nuclear weapon (of moderate yield) is now capable of achieving the same result in mere seconds.[30] A direct effect of this enormous firepower is the possibility of reducing the density of artillery and aviation support necessary for suppressing or annihilating the enemy, i.e., reducing the numbers of indirect fire forces necessary to achieve a favorable correlation.

Neutron weapons are, perhaps, the most influential of all the weapons of mass destruction. Reznichenko explains that

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[28]Lomov, p. 133.
[29]Reznichenko, pp. 6-36.
[30]Ibid., p. 6.

> Combat will become even more decisive, dynamic and fragmented, with considerable intermingling [***ochagovyy***] of the sides; the independence and role of the battalion tactical groups in the course of combat operations will grow; the probability of massive losses of personnel will increase the requirements of troop survivability.[31]

He goes on to outline the chief tasks of commanders in light of these weapons:

> ...promptly revealing and annihilating the enemy's nuclear weapons, including neutron weapons, and artfully utilizing them on the battlefield if the enemy initiates a nuclear war; promptly and efficiently exploiting nuclear strikes by friendly troops; improving the methods of troop operations in the face of massed use of nuclear weapons of the enemy, and methods of combatting his tactical and operational-tactical nuclear weapons; increasing the survivability of friendly troops and their resistance to the effects of nuclear weapons; learning to quickly restore the fighting efficiency of subunits, units and formations after nuclear strikes by the enemy, and conducting combat operations with limited resources.[32]

Reznichenko also identifies the imperative for dispersal, arguing that tactical units must dispose themselves in march, approach march, and combat formations so as to minimize the possibilities for losses, should nuclear means be used against them.[33]

Chemical and biological weapons are considered no less threatening by the Soviets. Of course, few contemporary Soviet publications acknowledge (or even allude to) potential Soviet use of these weapons. However, the Soviets have no less capability to use them than have their potential Western adversaries. Because these weapons can significantly alter force correlations, the Soviets stress (defensive) measures for countering their effects: prompt warning of enemy use; protective (anti-chemical) clothing and equipment; and rapid, thorough treatment of casualties.

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[31]Ibid., p. 7. [The Soviet term *ochagovyy* has no literal English equivalent, although it is roughly akin to the word "intermingling."]
[32]Ibid.
[33]Ibid.

Reznichenko cites the "main direction" of conventional weapons development as being towards high precision weapons; systems which "resemble tactical nuclear weapons" in terms of their potential to sharply increase the losses of personnel, armament and equipment. Among the more onerous weapons in this category he lists reconnaissance-strike and -fire complexes, automated fire control systems, anti-tank missile systems, guided missiles, and guided and cassette bombs. These new means raise the lethality of fire strikes while decreasing the response time of firing, resulting in a naturally greater role for the "long-range fire fight" in determining the course and outcome of combat. That the Soviets give significant importance to high precision weapons capabilities is readily apparent. No doubt, they figure prominently in COFM calculations:

> The success of modern combined-arms combat will depend in many ways on annihilation of the enemy's high precision weapons, on improvement of the entire system of his fire suppression, on finding effective means of capitalizing on the results of fire strikes, and on thoughtful organization of the protection of troops against attacks by the enemy's high precision weapons through the integrated use of protective properties of the terrain, engineering resources and improved methods of advancing and deploying subunits and units and of locating them on the terrain.[34]

Aviation support to ground combat is significantly increasing troop firepower and mobility through the addition and use of a third battlefield dimension-- airspace. Increasing numbers of highly maneuverable and heavily armed combat helicopters, carrying advanced anti-tank missiles, pose a major threat to armored subunits and units. Advanced multipurpose helicopters carrying infantry make possible the "aerial envelopment" of enemy forces at tactical depths. Larger transport aircraft carrying airborne forces provide much the same capability, but to operational and even strategic depths. Fixed wing bombers and fighter-bombers (ground support aviation) carrying enormous ordinance payloads provide mass destruction of enemy units in tactical and

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[34]Ibid., p. 11.

close-operational depths. Most all of these weapon systems may be configured with high precision munitions, greatly increasing their efficiency.

Thus, the Soviets cite three-dimensionality as becoming a more characteristic trait of combined-arms warfare-- leading to combat both along the front and in depth and to unclear distinction of the troops' line of contact.[35] Moreover, the Soviets are forecasting an even more significant role for aviation in the tactics of future offensive combat:

> ...we can suggest that under the influence of modern weapons and the continually increasing availability of aviation resources to the ground troops, in accordance with its purpose the offensive troop [formation]...will consist of two echelons-- a ground echelon, the missions of which would be to penetrate enemy defenses and exploit the breakthrough in depth, and an air echelon, created to envelop the [formation]...of defending troops in the air and striking their rear.[36]

The revolution in military technology has not overlooked the more conventional battlefield weapons-- infantry carriers, tanks, anti-tank systems, air defense systems, artillery, etc. --that played such decisive roles in World War II. Indeed, there have been significant increases in the mobility, firepower, and protection characteristics of most of these weapons. Infantry combat vehicles now possess the firepower of WW II tanks and have even greater mobility and firing range. Their deadly anti-armor missiles and rapid-fire cannons have generally extended the close battle space. Modern tanks are behemoths compared to most of their WW II counterparts, yet they are more highly maneuverable and are unsurpassed in firing rate and accuracy and in all-around anti-armor protection. (Most Soviet tanks even possess an anti-tank guided missile firing capability.) Their high-technology armors, armaments, and power trains have kept pace with anti-armor developments that sought to make them obsolete.

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[35]Ibid., pp. 11-13.
[36]Ibid., p. 86.

The Soviets consider that the role of modern anti-tank weapons is increasing. They believe the extended range, accuracy, and penetrating capability of these precision weapons is becoming decisive in close combat. Firing platforms include combat helicopters, infantry combat and infantry carrying vehicles, and tanks. Many are man-portable. Their sheer density in the close battle space poses an enormous threat to Soviet heavy armored units and subunits, especially where they are concentrated on main axes. The Soviets therefore stress the importance of joint suppression (or annihilation) of these systems by artillery, aviation, and other fire and electronic means.[37]

Air defense artillery systems have also undergone major technological improvements, making them ever more threatening to enemy aviation. Modern gun and missile weapons are increasingly more resistant to jamming and decoys, and have increased range and effective altitudes. The higher velocity and maneuverability and jamming resistance of current anti-aircraft missiles have vastly improved their kill probabilities. The impressive Soviet fleet of anti-aircraft guns and missiles, distributed throughout tactical, operational, and strategic depths is testimony to the value the Soviets place on airspace denial. Forestalling the adversary's use of battlefield airspace and his establishment of air superiority both assists in Soviet force protection and averts rapid, unfavorable shifts in the correlation of forces.

Modern tube and rocket artillery systems are no less important in present day measures of the firepower potential among opposing forces. Reznichenko notes the chief contributions of modern artillery systems as including greater precision, longer ranges, higher rates of fire, larger and more lethal ordinance, and greater ground mobility. These systems require less time and fewer numbers to achieve the necessary enemy destruction. They make possible the concepts of "maneuver by fire" and simultaneous destruction of the enemy at tactical and operational depths. Again, their contributions to modern battle's fluidity and dynamicness is underscored:

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[37]Ibid., pp. 14-16.

> The main goal of massing-- achieving superiority over the enemy in a decisive sector at the needed time-- is attained in a new way with modern resources of armed conflict: The concentration of fire of all types or nuclear strikes can almost instantaneously change the correlation of forces and equipment in a selected direction or sector.[38]

ESSENCE OF MODERN BATTLE AND OPERATIONS

The Soviets hold to the premise that "the content of battle is determined chiefly by the level of development of armament and military technology."[39] Their expressed views of modern warfighting-- both offensive and defensive -- bear out that premise. The offensive has been traditionally been considered the decisive form of battle and operations. Its goals are the total rout of the opponent and the capture of important terrain in a short time. Modern weaponry makes the offensive even more decisive. The ability to conduct long-range fire strikes, to achieve aerial envelopment of the enemy, and to rapidly concentrate (and disperse) forces has been made possible through the revolution in military technology.

Defensive combat and operations emphasize the retention of terrain and the repulsion of enemy attacks, so that favorable conditions are created for a transition to the offensive. The adversary's possession of weapons of mass destruction and high precision weapons requires greater (defensive) dispersion of friendly forces. Modern weapons and means in the Soviet force structure allow for greater dispersion of their formations, units, and subunits, while shortening the time required for transitioning to the offense. Reconnaissance-fire and -strike complexes provide fire concentrations on enemy forces throughout his depth, helping to forestall his offensive.

Because of the sophistication, range, lethality, and speed of modern weaponry, the two traditional forms of combat (operations)-- offense and defense --are becoming less distinguishable, in the Soviet view. However, the

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[38]Ibid., pp. 13-14, 32.
[39]Ibid., p. 21.

offensive remains the principal form to be used for gaining victory over an opponent. (And, this will likely remain so even as the Soviet leadership is shaping a so-called "defensive doctrine" for the Soviet armed forces.)

Reznichenko lists the following among the more important characteristic traits of modern, combined arms battle: decisiveness, high maneuverability, intensity, fast and sharp changes, diversity of methods, and an increase in spatial boundaries and pace.[40] These characteristics apply to both types of battle (operations) and reflect considerable influence by modern weaponry. The newer weapons inflict greater losses in a shorter period of time. Increased mobility enables tactical and operational forces to capitalize more quickly on the results of the fire strikes. Increased dispersal of forces and rapid changes in force disposition result in the absence of a continuous front (line of contact). Abrupt changes in the correlation of forces make possible the exploitation of tactical or operational opportunities.[41] A key to success is the optimal use of resources-- especially time.

The time factor in battle is a common denominator for all the characteristic traits of the modern battlefield. In fact, effective time management has become decisively significant for determining the course and outcome of combat (operations).[42] The Increase in weapons systems' speeds and rates of fire and the decrease in response times have, simultaneously, brought about increased (overall) rates of combat (operations) and even more complex interaction among the participating forces and means.[43] In the words of K. V. Tarakanov,

> It is precisely the correct determination of the required offensive tempos for each case, the wide use of maneuver from the very beginning of the battle, and the possible great depth of its conduct that primarily lead to the achievement of success- to victory.[44]

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[40]Ibid., pp. 23-26.
[41]Ibid., pp. 23-25.
[42]Lomov, pp. 157, 167.
[43]Ibid., p. 6.
[44]Tarakanov, p. 207.

TROOP CONTROL ON THE MODERN BATTLEFIELD

The obvious nexus for exploiting the characteristic traits of the modern battlefield is the Soviet troop control system. For it is this network of planning, organizing, decisionmaking, and execution monitoring that brings the combat potential of the forces to bear at decisive places and times. Altukhov summarizes this point rather well:

> ...the real correlation of the forces of the combatants in the course of military operations is determined not so much by potentialities as by the combat capacities of the opposing groups which are realized, and the degree of the realization of the combat capacities of the troops directly depends on the effectiveness of the control of them.[45]

Decisionmaking is, of course, the primary task of the control body--regardless of the echelon of operational or tactical command. Whether to choose one axis or another, where and when to commit one's allotted forces, how much of the enemy force is to be destroyed by fire strikes, what should be the objectives of the various force echelons, these decisions ultimately will determine the degree of success of the combat (operation). One of the chief aims of the Soviet troop control process is for its control body to determine the optimal (or most correct) decision variant. And, again, the time factor is important. Commanders and their staffs must make optimal use of the meager increments of time they have for planning and decisionmaking. Reznichenko states:

> The trait of modern combined-arms battle imposes high requirements on the training level of commanders and staff officers. Today, as never before, they must think creatively and quickly, and they must act resourcefully, boldly and decisively; they must persistently seek optimum methods of the conduct of battle in the specific situation and ensure their decisive, practical utilization.[46]

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[45]Altukhov, p. 3.
[46]Reznichenko, p. 25.

He goes on to outline the crucial role that foresight and forecasting have in the troop control process:

> Modern combined-arms battle requires all officers to display deep knowledge of military theory, a broad general scientific outlook, creativity and initiative, the art of operational and tactical foresight and the capabilities for forecasting the possible course of combat operations and for developing and assimilating new, more effective methods of the conduct of battle.[47]

DECISIONMAKING & AUTOMATED SYSTEMS OF CONTROL

Just as the revolution in military affairs has mandated a need for timely decisions and increased optimization of battlefield resources, so too has the revolution in military technology brought about a solution to these problems--automated systems of control. Their use makes it possible to sharply increase the rate of movement of men and materiel, to increase the destruction of enemy installations, and to rapidly gather and catalogue the various kinds of tactical and operational information that the control bodies need for their decisionmaking.[48] But perhaps most important, these systems enable the commander and his staff to forecast the outcomes of potential decision variants and to select or otherwise substantiate the optimal one.

The revolution in military technology has delivered the computer to the battlefield and its use has captured far-flung Soviet appeal. The computer's ability to mathematically model the processes of armed conflict at very high speed has given the commander a heretofore unprecedented capability for foresight. By modeling his options before committing troops to combat (operations), the Soviet commander can verify the optimal decision variant. Sophisticated mathematical models can be used to achieve ever more

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[47]Ibid., p. 26.

[48]V. M. Bondarenko, *Automation of Troop Control*, (Moscow: Military Publishing House), 1977. Translated by Joint Publications Research Service (JPRS L/8199), 4 January 1979, p. 179.

objective evaluations of the correlation of forces and means as well as the potential for (or mathematical expectation of) mission accomplishment. Bondarenko gives testimony to the importance of these methods:

> Mathematical methods are now becoming an inseparable aspect of the troop control process, and they are closely interwoven with such important elements of it as the evaluation of the situation, decision taking, and forecasting of the results of combat. These help the commander to determine the balance of forces of the sides, to assess the combat capabilities of his own troops, to make an optimum allocation of forces and means, to calculate the possible losses of personnel and military equipment, to assess the effectiveness of nuclear strikes, to solve the problems of optimum planning, target allocation, and so forth.[49]

The importance of this relatively new capability-- mathematical modeling vis-a-vis electronic computers --to the commander's decisionmaking process deserves further exploration. But first it is necessary to more fully develop the mechanics of the COFM methodology.

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[49]Ibid., pp. 137-138.

CHAPTER 3

THE MECHANICS OF COFM

Mathematical methods for studying the processes of armed combat serve as the necessary instruments for the qualitative basis of the decision making process aimed at providing the maximal effectiveness of forces and means drawn into operations.[1]

K. V. Tarakanov

Probably the most contentious aspect of any attempt to quantify the modern battlefield is the notion that the inherent values of the various weapons and means can be measured and compared against a single quantitative standard. Intuitively, the military practitioner may suspect the existence of such a relationship, but proving it is very difficult. Exhaustive historical studies have yet to reveal an infallible system for accomplishing the total quantification of battle; perhaps they never will. Regardless, Soviet military scientists have not been deterred from their quest for objectivity and optimization in military affairs.

Soviet military operations research (OR) seeks to reduce certain tactical and technical aspects of Soviet military science to measurable, objective indices from which decisions can be made or otherwise substantiated. A sub-element of Soviet military OR, the correlation of forces and means (COFM) methodology is considered a powerful tool for helping operational- and tactical-level commanders in their decisionmaking processes. As with all OR-related techniques, COFM's focus is towards the ultimate "goal" of a particular task--specifically, the direct numerical comparison of forces. Its principal mechanisms are: (1) the quantification of selected battlefield elements, and (2) the mathematical expressions (or formulae) which relate those elements in such a manner as to support decisionmaking. These mechanisms are used to develop conclusions about the status of opposing combatants at particular stages of

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[1]K. V. Tarakanov, *Mathematics and Armed Combat*, (Moscow: Military Publishing House), 1974. Translated by U.S. Air Force (FTD-ID(RS)T-0577-79), (AD-B043718), 15 August 1979, p. 100.

combat (operations). When combined with military art-- specifically, operational-tactical norms, tasks, and objectives --they may even reveal options for achieving the desired end-state or goal of the combat (operation). Because these COFM mechanisms play such an important part in Soviet military affairs, they deserve further examination.

QUANTIFICATION OF BATTLEFIELD ELEMENTS

First in the process of quantifying the battlefield is the derivation of combat potential for each of the constituent elements. Each battlefield system (consisting of men and materiel) has qualitative characteristics that can be expressed quantitatively. The more common characteristics for combat materiel include: range and precision; area of destruction; rate of fire; speed of the equipment; (armored or other means of) protection; and functional reliability.[2] Two general techniques may be used to determine the cumulative worth (or combat potential) of a system.

The first and simplest method may be referred to as the "proving ground" approach. This method is accomplished by careful selection of generic system parameters that influence the combat process and numerically scaling them. Each specific system's characteristics are measured in a proving ground environment, assessed against these parametric scales, and then entered into a weighted, arithmetic equation for determination of total combat potential. For example, the combat potential of a specific tank can be determined by: (1) measuring various firepower, protection, and mobility parameters during training exercises and/or under laboratory conditions; (2) cross-referencing the tank's performance in each parametric area to tables, charts, or graphs for a numerical score; and (3) entering these numerical scores into a weighted arithmetic equation for a cumulative score. A similar ***process*** is used for scoring other types of combat materiel (such as artillery, air defense, anti-tank,

[2] V. N. Zhukov, *Mathematics in Combat*, (Moscow: Military Publishing House), 1965, p. 37.

and infantry fighting vehicle systems); however, the parameters must be changed for each type of system.

A principal drawback to this system for assigning combat potential is manifested in its simplicity-- functionally dissimilar systems cannot (and should not) be measured against the same numerical standards. Functionally similar systems-- guns, mortars, and surface-to-surface missiles, for example --may be roughly measured against the same standards. However, it would be inappropriate to evaluate an artillery piece against the standards used for determining a tank's potential. They are "apples and oranges" so to speak, because they are employed differently, and for differing battlefield effects. Consequently, their potentials cannot be expressed in a single ***comparable*** measure: they are not additive.

Indeed, different weapons contribute differently to the overall force potential in any combat action (operation). While some systems directly influence enemy ground force destruction (tanks, artillery, helicopters, surface-to-surface missiles, infantry systems), others (air defense guns and missiles, air superiority fighters) are aimed at the destruction of enemy air and naval forces. Still other systems (radio-electronic jamming systems, engineer equipment) may have a large impact on the enemy's battlefield mobility, his ability to communicate effectively, or his ability to fire. Often, they simply amplify the effectiveness of friendly systems' employment (reconnaissance systems, radar systems, communications complexes, e.g.). Even though some systems cannot be linked directly to enemy force destruction, they remain an important aspect of combat potential. Yet, they defy measurement.

In short, simple ("proving ground") quantification of the functional parameters for battlefield systems does not provide the means for tallying a force's combat potential. Moreover, the system potentials are derived in a vacuum of other, functionally different systems, so they cannot illustrate the integrative benefits of heterogeneous force groupings.

A second technique for assigning combat potential to various battlefield systems may be referred to as the "digital computer" method. It involves the selection of a standard reference vehicle (or system) against which other, functionally similar systems are compared-- tanks compared to a reference tank, guns and mortars to a standard artillery piece, etc. The mechanism for comparing these systems is mathematical modeling on a digital computer. As with the first (proving ground) method, each system's characteristics are intrinsically treated. However, this method uses the outcome of the combat model for determination of the numerical potential of the system. (The actual system's quantifiable characteristics are modeled.)

For example, a specific tank-- say a T72 --is selected as the standard reference tank. From iterative (homogeneous group combat) modeling during a specified time period, a T72-equipped unit achieves an average (or mean) destruction of 10 tanks against an enemy tank unit that is equipped with M60A3 tanks. Next, T80 tanks are substituted for the T72 in the same model (with the time period, and all conditions and algorithms remaining the same). The mean enemy destruction from iterative modeling is determined to be 20. For the given conditions in the model, the T80 has a comparability coefficient of 2.0, with respect to the "standard" T72 tank. In other words, the T80 is assessed as having twice the effectiveness of the T72 if ***enemy tank destruction*** is the specified criterion of effectiveness.

Obviously, the second (digital computer) method for determining the numerical ratings of battlefield systems offers the flexibility of altering criteria (or measures) of individual system effectiveness. For example, one may prefer a measure of effectiveness that reflects both friendly and enemy tank destruction for a given time period in battle. Accordingly, and using the example above, if the T72-equipped unit were to achieve a loss-exchange ratio of 1.5 as compared to the T80 unit's 2.25, the T80 would be half again as effective as the T72, with the resulting comparability coefficient of 1.5.

The subtle differences in such an analysis are important. Whereas the T80 unit was twice as effective as the T72 unit in destruction of enemy tanks, it was only one and one-half times as effective in enemy tank destruction with respect to friendly tank preservation. In such modeling, selection of the most appropriate measures of system effectiveness is of paramount importance to the values assigned to weapons; which, in turn, will significantly affect all subsequent force correlation calculations.

As with the proving ground method, the digital computer method offers no solution to the problem of finding a common measure of system combat potential. It does, however, offer some distinct advantages to the military practitioner. In the words of V. M. Bondarenko:

> With [computers] it is possible to realize statistical models which rather completely reflect reality...computers open up the way to an organic synthesis of analytical and stochastic modeling, to reproducing combat in its dynamics....[3]

Modern combat materiel is so diverse and specialized, and battlefield variables so numerous that their interdependencies, today, can cause dramatic fluctuations in the correlation of forces. They can, in a moment, cause radical shifts in the potential outcomes of heterogeneous group combat (operations). Despite the memory capacity of his brain, even a military genius would find it impossible to cognize completely the interaction of all battlefield elements. The sheer volume of calculations and considerations involved are beyond human capacity. The collective influences of most battlefield variables and force organizations can, however, be reduced to computer algorithms. Therefore, mathematical models-- particularly, stochastic models that treat randomness in combat (operations) --offer a means for objective force-on-force comparisons.

Iterative runs of a mathematical model could, with suitable confidence, identify the values of diverse systems in terms of specific measures of effectiveness-- degree of enemy destruction, degree of friendly force preservation, rate of FLOT (forward line of own troops) or FEBA (forward edge of

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[3]V. M. Bondarenko, *Automation of Troop Control*, (Moscow: Military Publishing House), 1977. Translated by Joint Publications Research Service (JPRS L/8199), 4 January 1979, p. 117.

battle area) movement, etc. Repetitive modeling of these systems under changing conditions and types of combat (offense, defense, etc.) would further elucidate their value added-- although, not to some universally applicable standard. Such a process would facilitate the aggregation of ***similar*** systems' coefficients (tanks with infantry fighting vehicles; guns, mortars, and rocket artillery, together; etc.) for ***approximate*** combat potential assessments. Moreover, this process lends itself to the evaluation of individual systems potentials with respect to their battlefield adversaries (tanks versus tanks and other systems in an anti-tank defense; aviation systems versus enemy counter-air and anti-aircraft system complexes; etc.).

SOVIET METHODS FOR DERIVING POTENTIALS

Although there exists no reference that clearly details the latest Soviet methods for assigning combat potentials or comparability coefficients, Soviet discussions in the formerly restricted staff journal ***Voyennaia mysl'*** infer the use, in some form, of the latter (digital computer) technique. In October 1987, Strel'chenko and Ivanov discussed the use of mathematical models for depicting aircraft, artillery, antitank, armored vehicle and other material losses. The models were able to show depths of offensive penetration as "a basic function." The authors mentioned the use of "coefficients of commensurability" which were determined by heterogeneous means.[4] These inferences seem to confirm contemporary Soviet use of the process for determining system and unit potentials as suggested by L. Ya. Speshilov in 1981.[5]

Speshilov criticized the use of universally applicable coefficients as measures of combat potentials for the various types of armaments. He revealed that the Soviets were determining individual weapons potentials through use of a large-scale model of combat operations, and that these weapons potentials were being used in overall COFM evaluations. Although he conceded that

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[4]B. I. Strel'chenko and Ye. A. Ivanov, "Some Questions About Evaluating Force Ratios in Operations," *Voyennaia mysl'*, No. 10 (October) 1987, p. 58.
[5]L. Ya. Speshilov et al., "On the Question of the Correlation of Forces of Heterogeneous Troop Groupings," *Voyennaia mysl'*, No. 5 (May) 1981, pp. 44-51.

these potentials were "approximate determinations" of their respective systems' worth, he argued that they were only valid for the conditions of combat represented in the model from which they were derived. He also objected to the "measure of effectiveness" used in the model for determining weapons potentials-- "tempo of the troops' advance" --and cited "damage to the enemy" as being a more appropriate criterion.[6]

SEQUENTIAL COFM CALCULATIONS

Speshilov believed these combat potentials were limited in application to the calculation of COFM among homogeneous troop groupings-- in other words, formations and units comprised of the same or similar types of weapons systems. Therefore, he suggested the Soviets adopt a sequential method of COFM development that would yield more meaningful (and useful) force comparisons. Speshilov's three-phased process consisted of: [A] first determining the correlation of functionally similar systems (tanks, guns and mortars, helicopters, fixed-wing aircraft, etc.); [B] then determining the correlation of forces among adversarial systems (tanks versus anti-tank weapons, artillery and combat aviation against the like, and aviation versus enemy counter-air systems); and [C] determining the overall correlation of ground, air, and air defense forces.[7]

The first-phase formula for COFM of the same kinds of forces is:

[6] Ibid., pp. 44-49.
[7] Ibid., pp. 48-50.

The first-phase formula for COFM of the same kinds of forces is:

$$C_{\omega} = \frac{R_a}{R_b} = \frac{\sum_{i=1}^{n} N_i \bullet P_i}{\sum_{j=1}^{m} M_j \bullet P_j}$$

Where:

R = estimated combat value of the same types of weapons (e.g., tanks, guns, mortars, combat aircraft) among friendly (R_a) and enemy (R_b) troops.

P_i and P_j are coefficients of comparability (relating different weapons of a group to a single, standard weapon's potential).

N_i and M_j are the quantities of the i-type and j-type weapons in the hands of the friendly and enemy troops, respectively.

n and m are the numbers of types of weapons in the hands of friendly (i-type) and enemy (j-type) troops.

Speshilov's second-phase formula reflects the use of comparability coefficients that vary for each type of armament according to the types of opposing enemy weapons (which may counteract that friendly system) and the given types of combat.[8] The second phase equation (for COFM of different troop groupings) is written:

$$C_p = \frac{\Pi_a}{\Pi_b} = \frac{\sqrt{\sum_{i=1}^{n} \frac{N_i B_i}{\sum_{j=1}^{m} K_{ij} M_j}}}{\sqrt{\sum_{j=1}^{m} \frac{M_j B_j}{\sum_{i=1}^{n} K_{ji} N_i}}}$$

Where:

Π_a and Π_b are the combat potentials of friendly and enemy troops respectively.

N_i and M_j are the respective quantities of i-type and j-type weapons in the hands of the friendly and enemy troops.

K_{ij} and K_{ji} are the comparability coefficients for i-type weapons of friendly troops based on their relationship to enemy weapons of the j-type and vice versa.

B_i and B_j are coefficients of the effectiveness of use for a given type of combat of friendly (i-type) and enemy (j-type) weapons.

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[8]Ibid., p. 49.

This second-phase equation's "comparability coefficients" and "coefficients of the effectiveness of use" are computed and tabulated from mathematical models. Each comparability coefficient represents the quantity of "friendly" weapons of a given type that is equivalent to a "directly counteracting" weapon of a given type for a specified type of combat. Therefore, for each weapon system there exists not one, but rather, a number of different coefficients: one effectiveness of use coefficient for each specific type of combat and each functionally similar weapon among the friendly forces; and one comparability coefficient for each specific type (or model) of counteracting enemy system.

Thus, the T72 tank would have effectiveness of use coefficients comparing its potential with: T80 in offensive combat; T62 in defensive combat; T72M1 in defensive combat; T64B in offensive combat; etc. Similarly, the T72 would have unique comparability coefficients relating its potential to tanks such as the M1 Abrams, the British Challenger, the Israeli Merkava III, and the German Leopard II; as well as against anti-tank weapons like the Bradley Fighting Vehicle (with TOW II), the European HOT II missile, and the Swedish BOFORS BILL ATGM. The combat potentials that are measured in the phase two formula represent the characteristic qualities or the comparative combat capabilities of heterogeneous groupings.[9]

Speshilov's second-phase equations are used to compute three products that are of direct interest to operational and tactical commanders. First, the correlation of forces for tanks and anti-tank weapons gives a rough estimation of the "superiority in ground maneuver force." Second, the correlation of artillery and combat aviation in various periods of fire attack represents the "degree of fire superiority." Last, the correlation of aviation and air defense weapons represents the "degree of (or potential for gaining) air superiority."[10]

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[9]Ibid., pp. 49-50.
[10]Ibid., p. 50.

The third and final phase outlined by Speshilov is aimed at determining the "general or overall correlation of strike forces." But before such a calculation can be made, further (operational) modeling is required. Specifically, a mathematical model of the fight for gaining and maintaining air superiority must be run to determine the "residual" aviation forces that can be brought to bear in support of the ground troops. Once accomplished, these residual aviation systems may be combined with the previous tank / anti-tank and artillery calculations for final determination of the combatants' correlation of strike forces.[11]

Speshilov states that this final tally is not a simple, arithmetic summation of forces; but rather, a "calculation of an integrated and collective quality."[12] He does not provide a formula for this (final) computation but evidence suggests that such a method exists and is being used. Writing in the September 1989 edition of ***Voyennaia mysl'***, A.G. Terekhov uses the term "strike force" alongside Speshilov's other (phase two) types of correlations: "Norms combined with correlation of forces show: the force of the strike, fire strength, and the possibility of achieving air superiority."[13]

It is possible that Terekhov's "norms" prescribe the method by which COFM calculations are combined for the overall strike force calculation. These norms may require alteration of the tally for varying combat (operational) conditions. Intuitively, one would surmise that the Soviet commander would weight the importance of his "fire strength" and "tank / anti-tank force" correlations to correspond with: (a) the type of combat (operation)-- whether defensive or offensive; (b) the nature of his mission and tasks as assigned by higher headquarters; (c) the nature of the enemy's force structure, tactics, and positioning; and (d) the nature of the terrain and meteorological conditions. Other factors may influence the commander's final determination of his COFM, as well. So long as the commander can cite an objective basis for his

[11]Ibid.
[12]Ibid.
[13]A. G. Terekhov, "A Methodology for Calculating the Correlation of Forces in Operations," *Voyennaia mysl'*, No. 9 (September) 1987, p. 53.

calculation of the final correlation, he should be well within the prescribed tenets of Soviet military science.

Having explained the likely Soviet methodology for deriving and aggregating combat potentials, there remain some fundamental perplexities about the application of COFM. Speshilov's formulae may be fine for "static" COFM calculations at the outset of a battle or operation, but the Soviets place great emphasis on foreseeing the ***course and outcome*** of armed conflict. So, how can COFM be calculated as a function of time-- throughout the duration of the fight? And what of the imponderables? How can COFM be useful without mathematically accounting for friendly and enemy tactical techniques and procedures; non-firing systems that contribute to mission accomplishment; the morale and training proficiency of the combatants; and other (variable) battlefield conditions such as weather? These questions must be resolved before COFM can be considered feasible for use in decisionmaking. Recent Soviet literature seems to provide the answers.

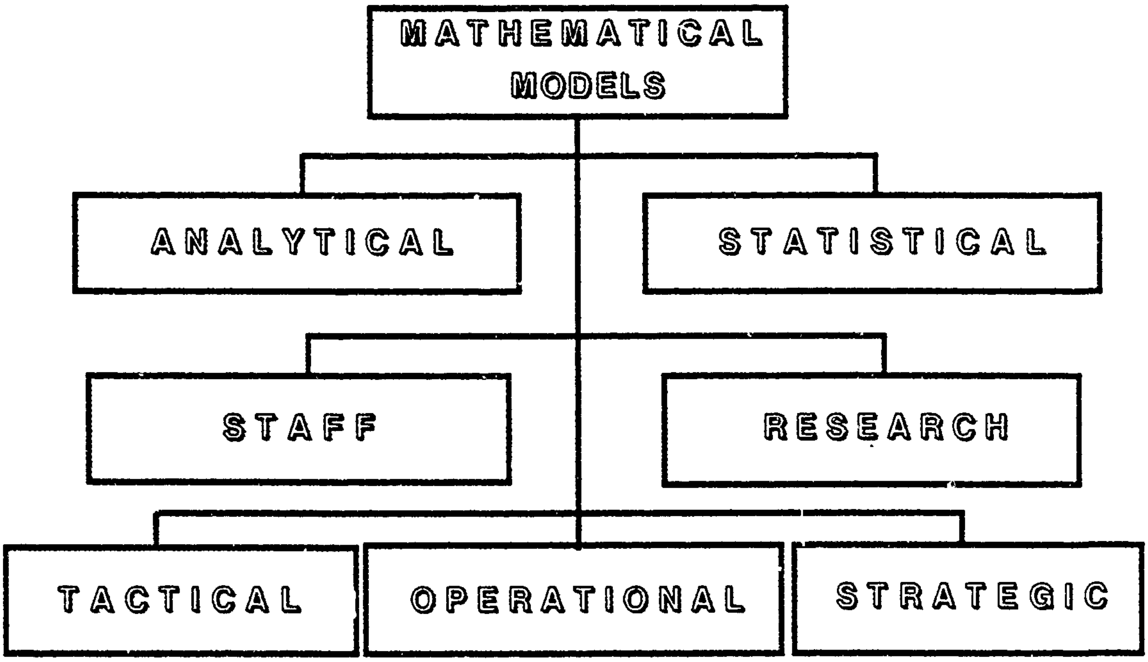
MATHEMATICAL MODELS OF COMBAT

In his September 1987 article in ***Voyennaia mysl'***, A. G. Terekhov decried decisionmaking based solely on the "simple summation" of the combat potentials of the attacker and defender in terms of the divisions' weapons: for such calculations neither replicate the actual battlefield situation nor convey the true combat potentials of forces in an operation.[14] According to Terekhov and a host of other Soviet authors, mathematical models are the essential mechanisms for calculating the quantitative and, in the future, the qualitative correlation of forces.

Babadzhanyan's diagram of the variety of Soviet mathematical models in use by the Soviet military is given in Figure 2.[15] Although these models are still

[14]Ibid., p. 54.
[15]A. Kh. Babadzhanyan et al., *Tanks and Tank Troops*, (Moscow: Military Publishing House), 1980. Translated by Joint Publications Research Service (JPRS L/9697), 29 April 1981, p. 350.

considered inadequate for complete (objective) treatment of ***all*** battlefield factors, they do satisfy the need for portraying the general course and outcome of the combat (operation) and they facilitate rapid, repeated COFM calculations. But most importantly, they provide the objective basis for substantiation of the commander's decision.



[FIGURE 2]

In his 1974 edition of ***Mathematics and Armed Combat,*** K. V. Tarakanov explains the essential differences among the many Soviet analytical and statistical models. He states that analytical models are used to describe comparatively simple operations through the establishment of equational relationships between system parameters and effectiveness criteria. Analytical models may include a variety of mathematical techniques ranging from simple arithmetic functions to the ever-popular differential equations. Soviet statistical models are often characterized by the inclusion of Monte Carlo techniques for the treatment of randomness in the combat (operational) process. They are used when the process to be modeled is extremely complex, where a large number of parameters interact. Tarakanov explains that statistical models possess substantive advantages over their analytical counterparts, and are devoid of profound assumptions and limitations.[16]

Simple (or elementary) COFM calculations-- like Speshilov's formulae previously mentioned --are examples of "static" Soviet models. They are one-dimensional in that they provide a "snapshot" of force superiority without distributing it over time or space on the battlefield. However useful these static correlations may be for simple, tactical applications, the Soviets consider them inadequate for substantiating military decisions at the operational level. Other objective factors must be determined, as well.[17]

Tarakanov develops the mathematical theory behind a number of models which which focus on the three indices of effectiveness that are prevalent in Soviet modeling and (together with COFM calculations) that help to substantiate military decisionmaking. They are: **the degree of enemy destruction, the degree of preservation of the friendly forces**, and **the rate or degree of advance of the attacking troops.**[18] The first two indices are common to what may be referred to as "dynamic" combat modeling-- models which display damage infliction to the forces as a function of time.[19] The algorithms of these models make use of advanced mathematical techniques such as queueing theory, Markov processes, and modified Lanchester-type equations. Because these models measure attrition over time, their algorithms may be formulated to give the commander his general correlation of forces over time. But, despite their sophistication, "dynamic" models fall short of forecasting a complete mathematical picture of the course and outcome of operations. Spatial development of the battlefield is missing.

To achieve a more "kinematic" representation of the battlefield the Soviets have developed what they call space-time models. Through the use of partial differential equations-- very similar to those used in mathematical

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[16]Tarakanov, pp. 166-167.
[17]Terekhov, pp. 58-61.
[18]Tarakanov, p. 206.
[19]Ibid., p. 168.

physics --the Soviets have upgraded their mathematical models to account for spatial variables that influence FLOT or FEBA movement over time.[20] Mobility-influencing terrain factors such as relief, soils, and obstacles are portrayed alongside man-made features and combat engineer work in these models. This gives the Soviet commander the capacity to measure maneuver and attrition simultaneously, thus resulting in a full mathematical perspective of objective factors influencing the course and outcome of an operation. The correlation of forces at discrete points of time and at specific locations (or regions) of the battlefield is a by-product of space-time models.

In short, the so-called "kinematic" models provide the commander three key indices of effectiveness-- enemy destruction, friendly force preservation, and rate or degree of troop movement --as well as the dynamic correlation of forces; all of which are important to his decisionmaking process.

Strel'chenko and Ivanov confirm that such "subjective" factors as morale, political training, psychological preparation, troop proficiency, and command and staff proficiency are still not treated directly in the latest Soviet models. Because these "qualitative" factors do not reliably yield to quantification, their influence on the course and outcome of the fight are decided heuristically.[21] Therefore, it is left to the commander "artfully" to combine the objective indices (or measures) of effectiveness obtained from his models with heuristic judgements about the unquantifiable in arriving at military decisions. In the words of V. G. Reznichenko:

> In order that planning would be realistic and scientific, considering just the quantitative correlation of the forces of the belligerents and qualitative assessment of their capabilities for fire and maneuver are not enough. It is no less important to carefully account for the qualitative status of the resources-- the combat proficiency of the troops, the preparedness of commanders and staffs at all levels, the combat experience of the units

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[20]Ibid., pp. 206.

[21]Strel'chenko and Ivanov, pp. 55-56.

and subunits and the physical and moral preparedness of the personnel for their combat missions. [22]

SUMMARY

Thus far, discussion of the COFM methodology has focused on its mechanical composition; the two constituent elements being the development of combat potentials and their aggregation for objective force comparisons. COFM has been described as a product of Soviet forecasting techniques and Soviet military operations research; having been developed for application in the commander's process of balancing resource allocations in his quest for the optimal decision. COFM has been shown to be the objective methodology which arrives at three key categories of force superiority: the degree of fire superiority; the degree of (or potential for gaining) air superiority; and the overall strike force of the belligerents. Further, COFM has been discussed in light of its relationship among the three levels of Soviet mathematical models-- static, dynamic, and kinematic.

An elaboration of COFM in its battlefield application will follow in the next chapter. It will detail how the commander and his staff make practical use of the COFM methodology in their planning and decisionmaking processes. It will reveal how valuable COFM is, in helping commanders with their most difficult decisions about the optimal commitment of men and materiel in pursuit of mission fulfillment.

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[22] V. G. Reznichenko et al., *Taktika*, (Moscow: Military Publishing House), 1987. Translated by Joint Publications Service (JPRS-UMA-88-008-L-I), 29 June 1988, p. 36.

CHAPTER 4

COFM'S ROLE IN OPERATIONAL AND TACTICAL DECISIONMAKING

***...The conclusions obtained as a result of quantitative research are not a decision in the full sense of the word, but only the basis for taking a decision....*[1]**

V. Afanas'yev

The Soviet military-political leadership is currently re-thinking its general doctrine for war in light of: (a) its recent attempts at rapprochement with the West; (b) its internal economic plight; and (c) its ongoing arms control negotiations with NATO. The author thinks it premature to forecast significant deviations in Soviet military art and science; at least until Western analysts are able to decipher the new Soviet "defensive doctrine" and to determine the constituent manifestations of "reasonable sufficiency." After all, the one constant in ***perestroika*** (restructuring) and ***glasnost*** (openness) has been change; most of it unpredictable. Therefore, the author will refrain from speculating about such changes, except where the Soviets, themselves are forecasting them.

SOVIET MILITARY DECISIONMAKING

According to Altukhov, the "creative and primary task" of military control is decisionmaking.[2] It is the commander's decisionmaking process that determines the plan of combat (operations), the combat tasks for subordinate forces, the coordination of their battlefield activities, the provisioning of these forces, and the methods of their control. The process requires the assimilation

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[1]V. M. Bondarenko, *Automation of Troop Control*, (Moscow: Military Publishing House), 1977. Translated by Joint Publications Research Service (JPRS L/8199), 4 January 1979, p. 171.

[2]P. K. Altukhov, *Basis of the Theory of Troop Control*, (Moscow: Military Publishing House), 1984. English Translation, p. 15.

of senior headquarters' tasks and situational information about battlefield conditions as well as exceptional operational efficiency on the part of the commander.[3] Sound decisionmaking requires a deep and penetrating knowledge of the theory of military art as well as a strong appreciation for the capabilities of the combatant forces.

Ivanov states that the "soundness and timeliness in decisionmaking depend to a great extent on the methodology used."[4] He cites the essence of the decisionmaking methodology as being:

> the totality of modes and methods of creative thinking of the commander based on objective laws and principles and also the organization of his work in conjunction with the officers in the control organs while making the decision.[5]

The decisionmaking methodology, he says, must purposefully assist the commander in finding timely, well-founded solutions to complex battlefield problems. Its requirements include universality, flexibility, simplicity, and clarity. But, most importantly-- in the Soviet view --the methodology must remain consistent with "Marxist-Leninist dialectics, the theory of knowledge, logic, the laws of armed combat and the principles of military art."[6]

V. I. Lenin's preoccupation with the "objective world" has come to permeate Soviet military thinking. As a result, the Soviet decisionmaking process is decisively influenced by ***objective*** (friendly, enemy, and battlefield environment) information; guided by the ***objective*** evaluation (forecast) of the course and outcome of the fight; and focused on the ***objective*** tasks which

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[3]Yu. V. Chuyev and Yu. B. Mikhaylov, *Forecasting in Military Affairs.* Translated by the Translation Bureau, Secretary of State Department, Ottawa, Canada, (Washington, D.C.: U.S. Government Printing Office), 1975, p. 63.

[4]D. A. Ivanov et al., *Fundamentals of Tactical Command and Control*, (Moscow: Military Publishing House), 1977. Translated and published under the auspices of the U. S. Air Force, (Washington, D. C.: U. S. Government Printing Office), 1984, p. 184.

[5]Ibid., p. 185.

[6]Ibid.

dictate mission fulfillment. The objective nature of Soviet military thinking is clearly manifested in the methodology and process of operational and tactical decisionmaking.

The Soviet commander's methodological model for making tactical decisions is given at Figure 3. (Although front and army commanders have a much broader scope and greater responsibilities than have their tactical counterparts, the essential elements of this methodology are applicable to operational decisionmaking, as well.) According to Ivanov, two component inputs drive the commander's decision process. First is mission analysis-- the senior commander's concept for combat action and the specific tasks which must be accomplished. This input requires the commander to "precisely conceptualize:" (a) the objective of the forthcoming fight; (b) the means, times, and methods for reaching that objective; and (c) the requirements of his own decision, to include the actions of subordinate troops. The second input is the situation estimate, which is usually generated by the staff. It includes analysis (and objective expression) of all battlefield conditions which may influence the course and outcome of combat operations.[7]

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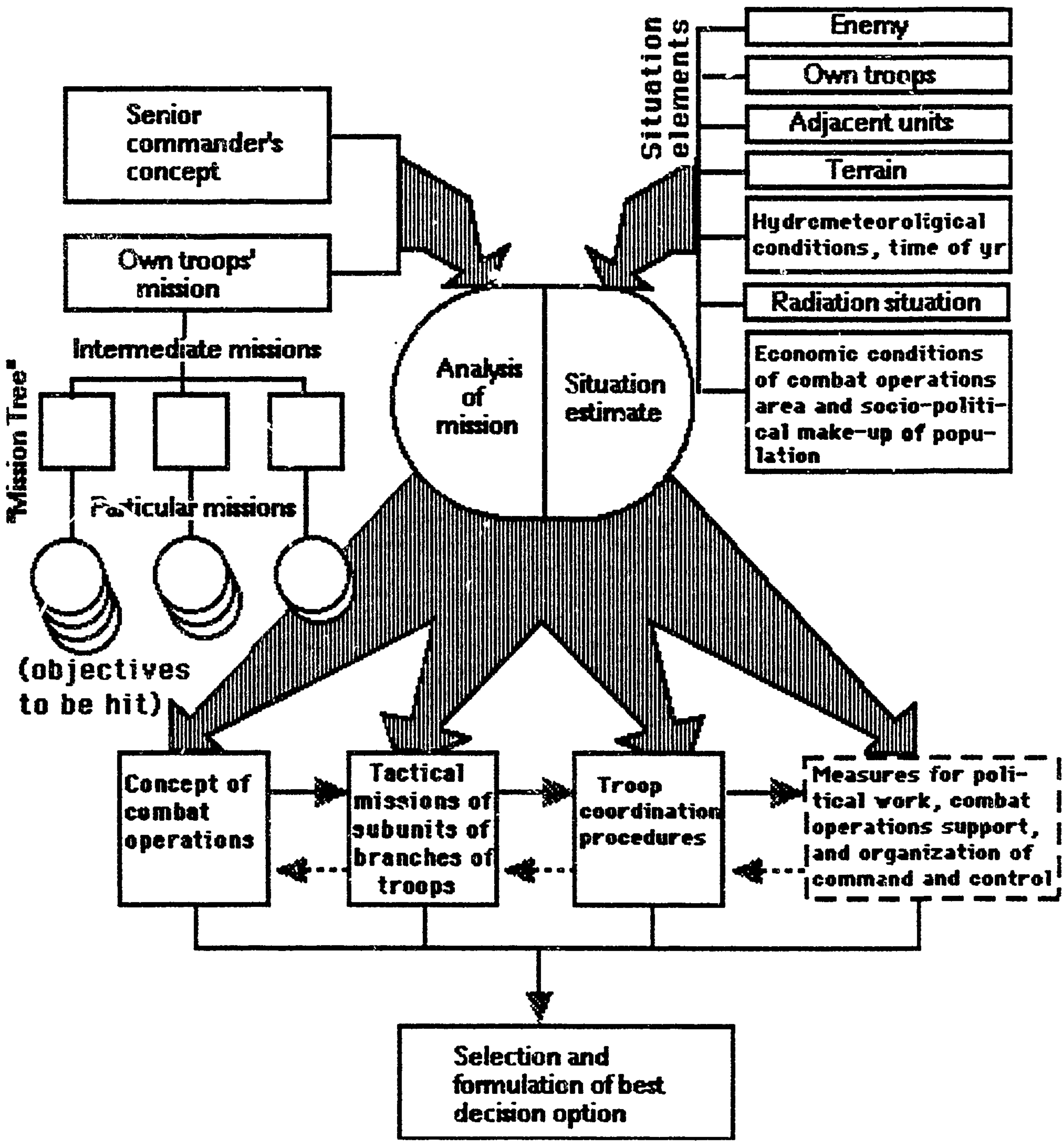
[7]Ibid., p. 188.

Commander's Decisionmaking Methodology



[FIGURE 3]

Curiously, the Soviets do not prescribe regimented procedures for translating the commander's mission analysis and situation estimate into a decision. To the contrary, Ivanov indicates this is the creative aspect of the process.[8] Commanders are expected to formulate decisions using synthesis, deduction, and induction. They rely on heuristic judgement in developing potential decision variants and then select the most appropriate one for further, more detailed planning and transmission to subordinate units. In short, each commander will uniquely conceive his decision variants.

However individualistic his process for getting there, the form of the Soviet commander's ultimate decision will be as prescribed in the above methodology-- a concept of combat operation, tactical missions for subordinate units, troop coordination procedures, and other (support) measures to be taken. The concept will normally include such elements as: the (enemy) objectives for the strike; the sequence for striking the enemy; the location and timing of the main effort; and the force's organization for combat.[9] (The reader will note little difference between these elements and those common to the U.S. Army's "concept of the operation.")

Chuyev and Mikhaylov have charted the important interrelationship between quantitative methods and the commander's decisionmaking process, as depicted in Figure 4.[10] Here, the reader will notice the same start and end points that were illustrated in Figure 3 (Ivanov's decisionmaking methodology); however, this diagram of the process highlights the use of forecasting and OR methods (such as diagrammatic planning, critical path method, etc.) in the flow.

The sketch reflects the possibility for bypassing the use of forecasts and OR-- using only the (initial) available information and the commander's heuristic judgement (experience, intuition, and knowledge) in arriving at a decision. Such behavior should, however, be considered non-standard or exceptional--

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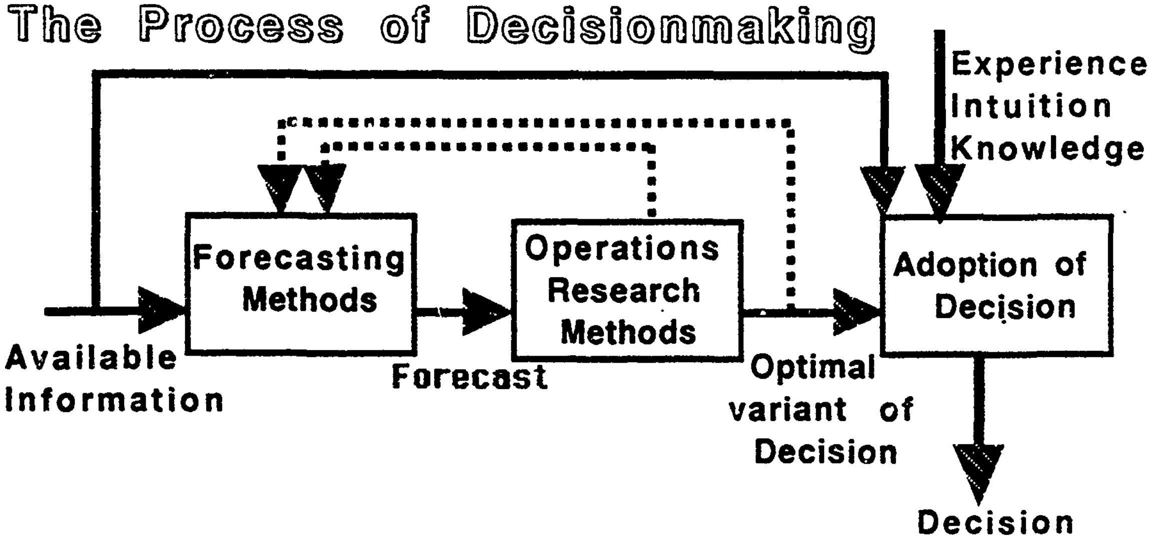
[8]Ibid., pp. 188-197, 204.
[9]Altukhov, p. 117.
[10]Chuyev and Mikhayiov, p. 216.

perhaps to be used when there is too little time for detailed planning and execution of assigned tasks. Throughout the military establishment, Soviet commanders are instilled with a deep appreciation for the use of quantitative methods in optimizing their use of resources and substantiating their decisions. In fact, Figure 4 subtly suggests that the "optimal variant of decision" cannot be achieved without the use of OR and forecasting: it lies on the path from "OR methods" to "adoption of decision."



[FIGURE 4]

It is his quest for an "optimal" or most correct decision variant that drives the Soviet commander towards mathematical substantiation of his intentions. Only through achievement of his assigned tasks-- which usually include a specified minimum level of enemy destruction, a specified maximum level of acceptable friendly losses, and specified space-time objectives --will his decision be considered appropriate. Because his tasks are mutually competitive, the commander has to find the right apportionment of forces and means, their optimal (spatial) configuration, and the most suitable timing for their employment. Once he has arrived at a preferred decision variant, the Soviet commander then models the combat (operation) to ascertain the likely outcome(s). By way of the forecast the commander mathematically substantiates his decision. Moreover, insights gained from the model may well help him make adjustments to his plan; i.e., to optimize the available resources. All of this is made possible by the military OR tools at his disposal.

Preeminent among these military OR and forecasting tools available to operational and tactical commanders is the COFM methodology. K. V. Tarakanov emphasizes its significance at the operational level rather well:

> The most important question which should be resolved by the commander...is the question of the correlation of forces and means. The commander and his staff, planning an operation, should, at every stage in its development, strive to have such a correlation of forces of the sides so that probability of mission accomplishment would be close to one.[11]

D. A. Ivanov infers the same sort of dependence on COFM at the tactical level: "...On the basis of these calculations, the commander and staff determine the number and correlation of forces required for successful accomplishment of the assigned mission...."[12]

As is evident, the COFM approach to objectivity and optimization is deeply imbedded in Soviet operational-tactical decisionmaking. Its practical uses deserve further elaboration.

Probably the most basic (and essential) question confronting the operational commander, in the course of armed conflict, is whether to attack or to defend. Tarakanov offers a simple application of COFM in resolving this most important question:

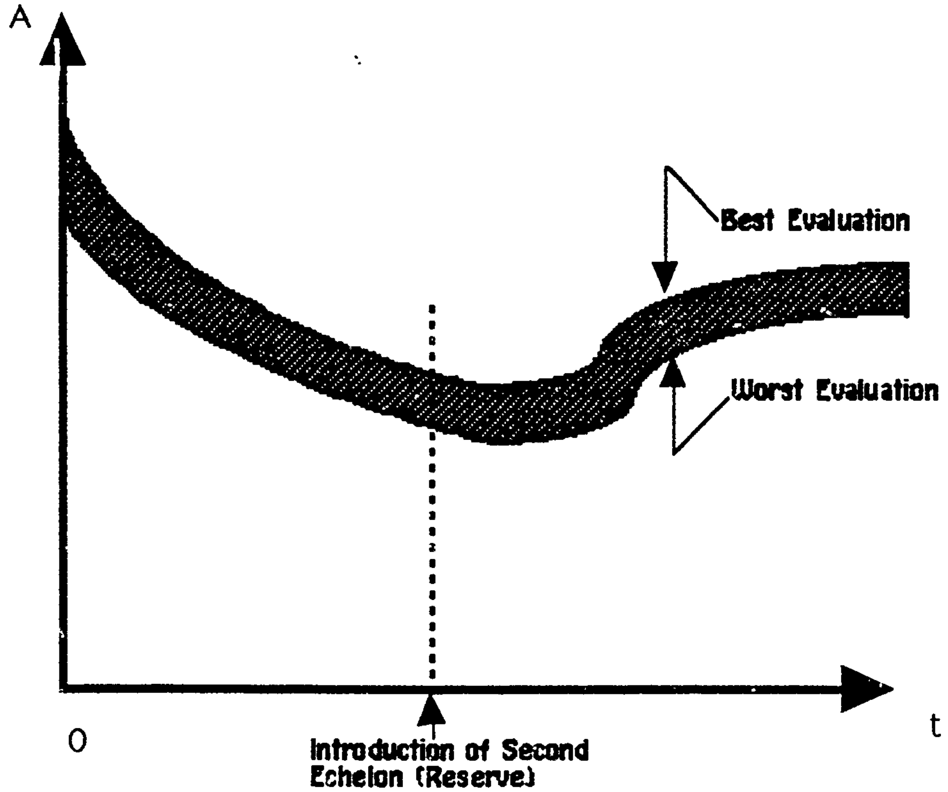
> If the correlation of forces and means in accordance with accepted criteria is sufficient for conducting an offensive, then the commander and his staff will organize and carry out an offensive. But if this correlation of forces and means changes in favor of the enemy, then the forces, as a rule, either shift to defense in their full complement or a part of the friendly

[11]K. V. Tarakanov, *Mathematics and Armed Combat*, (Moscow: Military Publishing House), 1974. Translated by U.S. Air Force (FTD-ID(RS)T-0577-79), (AD-B043718), 15 August 1979, p. 362.
[12]Ivanov, p. 208.

> forces shifts to defense in individual sectors of the front and the remaining forces and means continue the offensive in other sectors.[13]

So, given that the Soviet commander may determine his basic type of combat from analysis of the general correlation of forces and means, is it also possible that he might use a COFM assessment to identify when to introduce certain forces into the fight? Figure 5 graphically conveys the answer in the affirmative.

CHANGE IN STRENGTH OF AN OPPOSED FORCE GROUPING



Where "A" is the strength of the Force Grouping and "t" is time. The shaded area represents the probabilistic variance in the outcomes of the model.

[FIGURE 5][14]

13Tarakanov, p. 363.

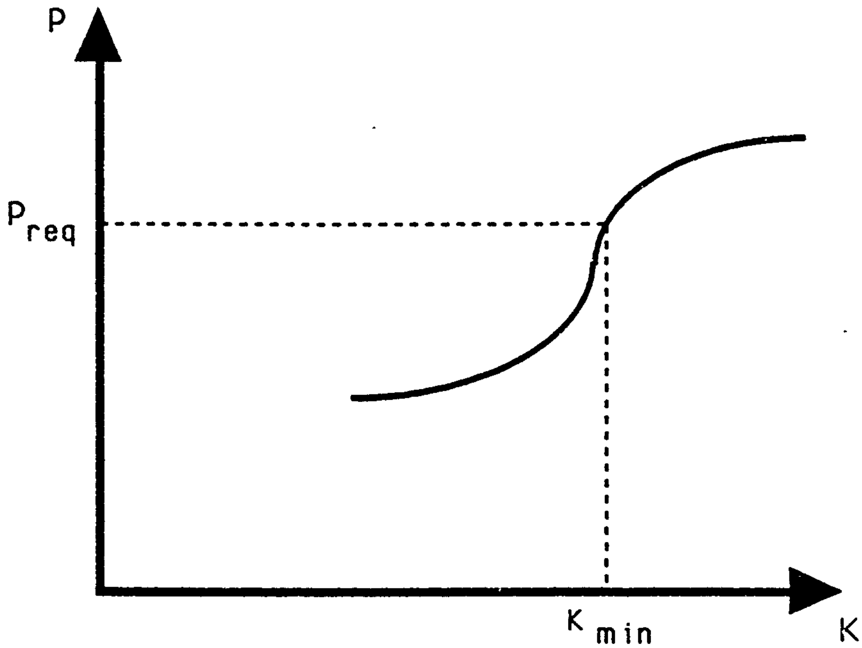
14Ibid., p. 366.

Through use of mathematical models available to him at his "control post," the Soviet commander can play out his decision variant. Moreover, he can model the course and outcome of the impending operation to determine the optimal timing of successive force introduction-- in the case of Figure 5, the introduction of his second echelon or reserve force. The Soviet use of a stochastic model is evident, in this case, by the depiction of a band (shaded area) of possible force strengths over time. The commander can easily visualize the point at which his force strength dips below an acceptable standard (or norm), thereby identifying the point in time for follow-on or reserve force commitment.

A further extension of the computer's capabilities is the plot of the general correlation of forces, itself, for use in decisionmaking. The resulting curves could well resemble those in Figure 6, as suggested by Tarakanov.[15] Here, the commander is searching for the minimum COFM necessary for achieving a specified probability of success in an upcoming operation, given the strength of the respective sides and other battlefield conditions. As with Figure 5, this graph assists the commander in apportioning his forces for optimal employment.

[15] Ibid., p. 367.

PROBABILITY OF SUCCESS AS A FUNCTION OF COFM



Where K_{min} is the minimally attainable Correlation of Forces in which the probability of mission accomplishment (P) is no less than that assigned.

[FIGURE 6]

COFM IN FRONT AND ARMY OPERATIONS

The U. S. Army's Soviet Army Studies Office (SASO) has compiled a superb reference manual that describes the nature, form, and content of contemporary Soviet Army operations and tactics.[16] It would be of little benefit, here, to repeat that fine work. Therefore, the following discussion of operational and tactical methods is meant only to expose manifestations of the COFM methodology, and not to provide an all-encompassing review of Soviet military art.

Soviet front and army operational planning norms for a strategic offensive in Europe have been aptly reduced to a single graphic (Figure 7) by John G. Hines in his article, ***Soviet Front Operations in Europe-Planning for Encirclement.***[17] This schematic illustrates the Soviets' perception of the objective depths and timing necessary for successful force employment in light of their COFM with opposing NATO forces.

Through meticulous planning and objective modeling the Soviets have arrived at normative figures for their echeloned armies that will, in their view, facilitate the rapid penetration of NATO's forward defenses. These rapid breakthroughs are immediately exploited by OMG (operational maneuver groups) and second echelon armies into NATO operational depths within 5-8 days. The resulting breakdown in the coherence of NATO defenses and the intermingling of the opposing forces is considered, by some, to forestall NATO use of theater strategic and operational-tactical nuclear weapons. Given success in the fronts' initial operations, exploitation into NATO strategic depths (500-800 kilometers) is considered possible in less than 14 days.

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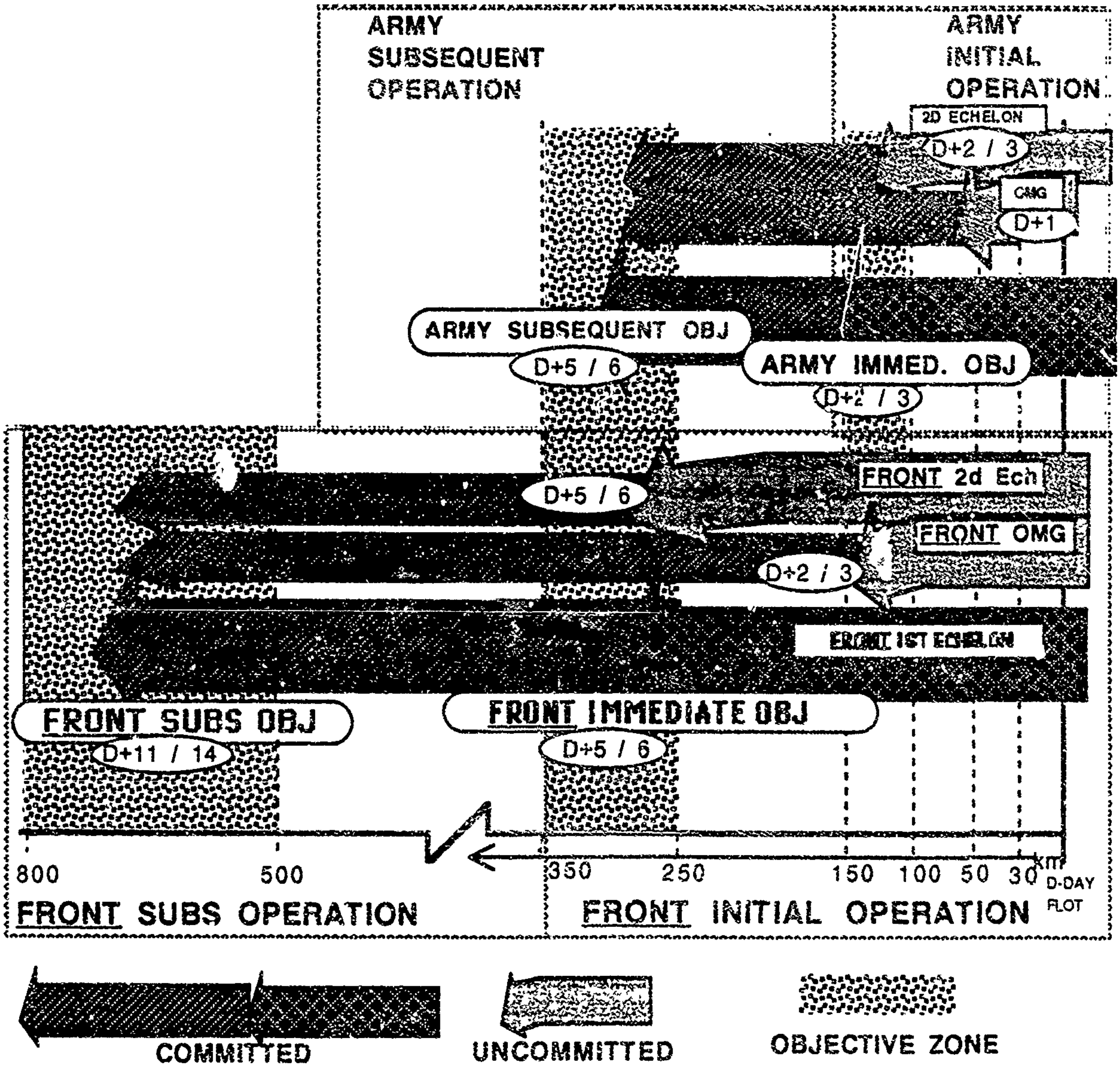
[16]David M. Glantz et al., *The Soviet Conduct of War*, (Ft. Leavenworth, KS: Soviet Army Studies Office), 30 March 1987. [Pages 1-68 provide a succinct but comprehensive synopsis of Soviet operational art and tactics. Serious students of Soviet military art would be well served by acquiring a copy.]

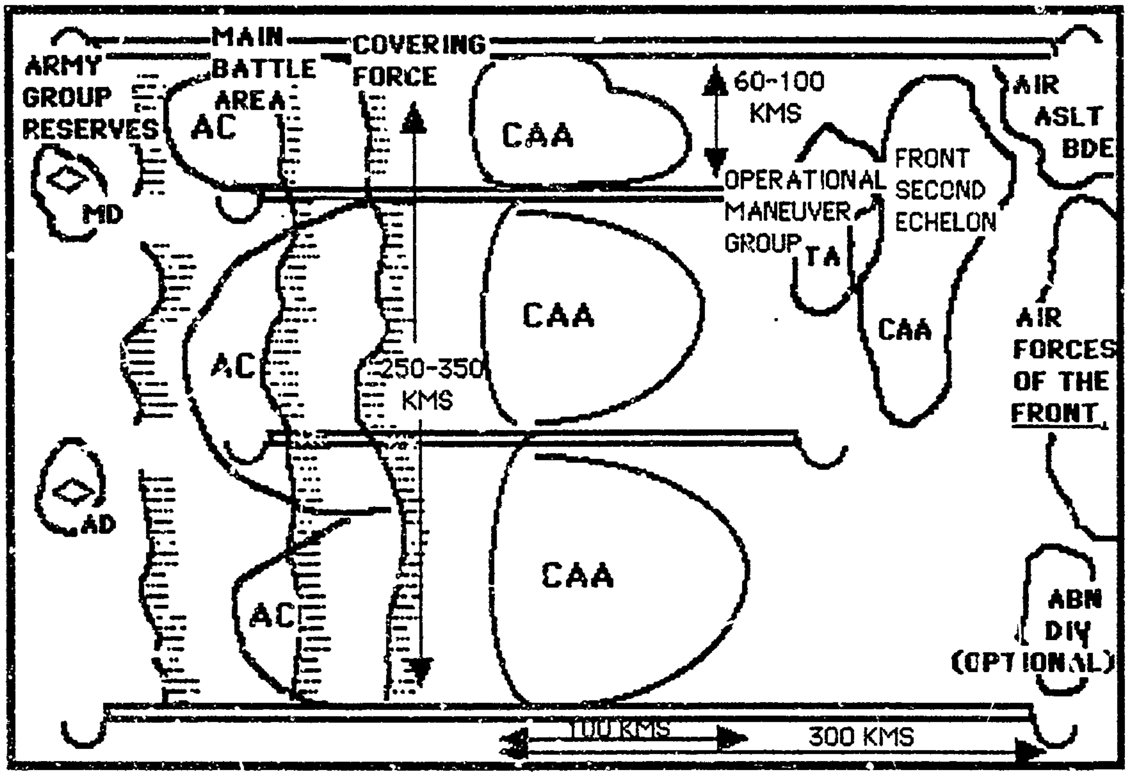
[17]John G. Hines, "Soviet Front Operations in Europe-Planning for Encirclement," *Spotlight on the Soviet Union*, (Oslo: Forsvarets Hogskoleforening), 1986, p. 100.

FRONT AND ARMY OFFENSIVE OPERATIONS



[FIGURE 7]

FRONT OPERATIONAL FORMATION-1987 AGAINST A FULLY PREPARED DEFENSE



[FIGURE 8]

Soviet front offensive operations may take one of three different force configurations depending upon the enemy's defense posture-- whether unprepared, only partially prepared, or fully prepared. Frontages for the fronts' armies, the number of armies in each frontal echelon, and the objective depths vary appreciably with the nature of the enemy forward defenses. Figure 8 depicts the front's traditional arrangement for offensive operations against a fully prepared NATO defense.[18] (This is not meant to infer a Soviet willingness to allow NATO preparation time for general war; rather, it is intended to illustrate

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[18]Glantz, p. 35. [The illustration provided by SASO has been adjusted by the author to reflect the most current Western understanding of the Soviet front offensive. The front second echelon will be positioned to sustain the efforts of the first echelon, principally on the front main attack axis-- in this case, the northern CAA. The front second echelon will usually be positioned to the rear of the OMG-designated force.]

the front's configuration should NATO have the necessary preparation time for a well-prepared, forward defense.[19])

Noteworthy are the presence of a strong second echelon and the wide variation of frontage each army may be assigned (60-100 kilometers). No doubt, these planning factors take into account the possibility for weighting the front main effort by achieving a sufficiently favorable correlation of forces for penetration on at least one axis. Once a penetration is achieved, the correlation can be sustained through introduction of second echelon armies, while the frontal OMG exploits into operational depths.

Figure 9 presents the configuration of frontal forces as they might appear in defensive operations.[20] Note the presence of the security zone, two distinct echelons containing the characteristic three main defensive belts, and a strong front counterattack force. Again, the influence of COFM is underscored. Deep echelonment of forces among the defensive belts exacts a heavy toll from the attacking forces, thereby reducing the attacker's favorable COFM. It also gains the necessary time for generating a strong counterattack where the correlation of forces may be equalized, or even made favorable so that the defending Soviet front may transition into an offensive.

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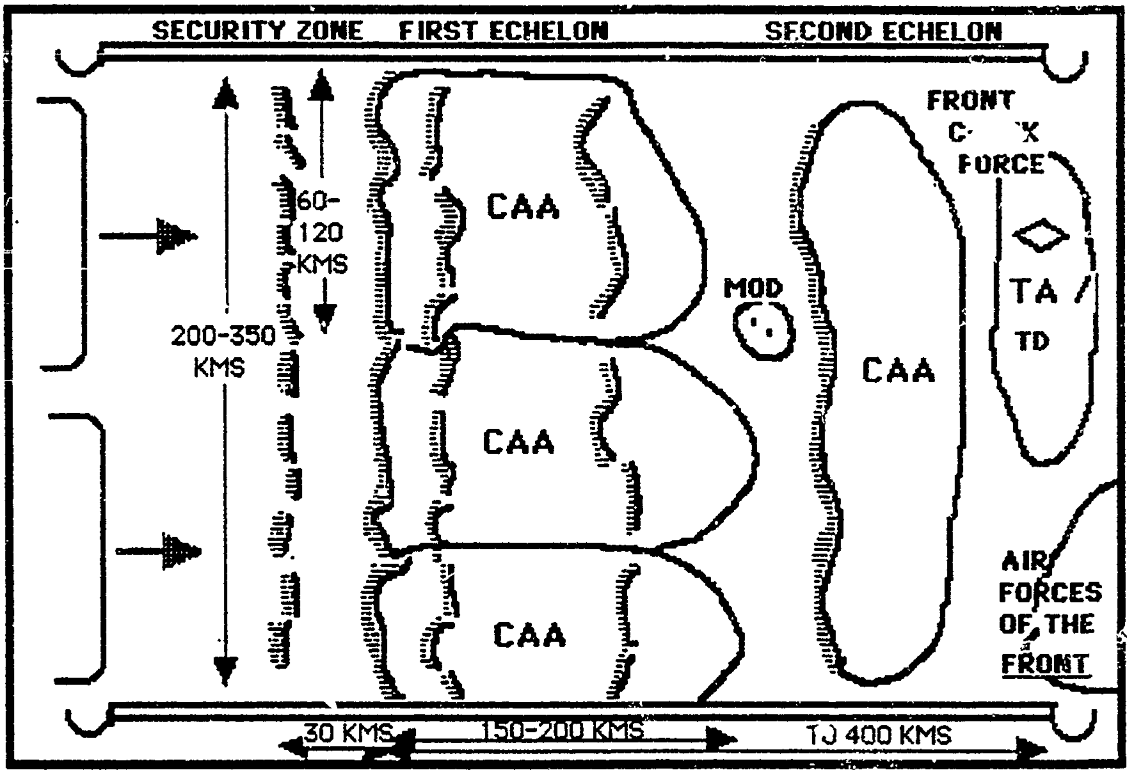
[19]The author notes that Soviet writing reflects a natural preference for attacking an unprepared or only partially prepared defensive force. The Soviets place great emphasis on strategic and operational surprise, principally to forestall a prepared enemy defense. This reduces the coherence and strength of the defender, thereby weighting the COFM in favor of Soviet forces.

[20]Ibid., p. 43.

FRONT OPERATIONAL FORMATION- DEFENSE 1987



[FIGURE 9]

Figure 10 illustrates the Combined Arms Army (CAA) in its array for attacking a fully-prepared NATO defense. Here, the reader will note the specific designation of both main and supporting efforts.[21] By restricting the frontage over which the "main strike grouping" will attack, the Soviets are, in effect, weighting the COFM on that axis. The presence of a strong second echelon facilitates the introduction of follow-on forces to sustain the COFM or to exploit first echelon penetrations into the enemy's operational depths. In addition to maneuver forces, the Soviets will heavily weight the main effort with front and army artillery (i.e., generate a significant correlation of strike weapons); this to

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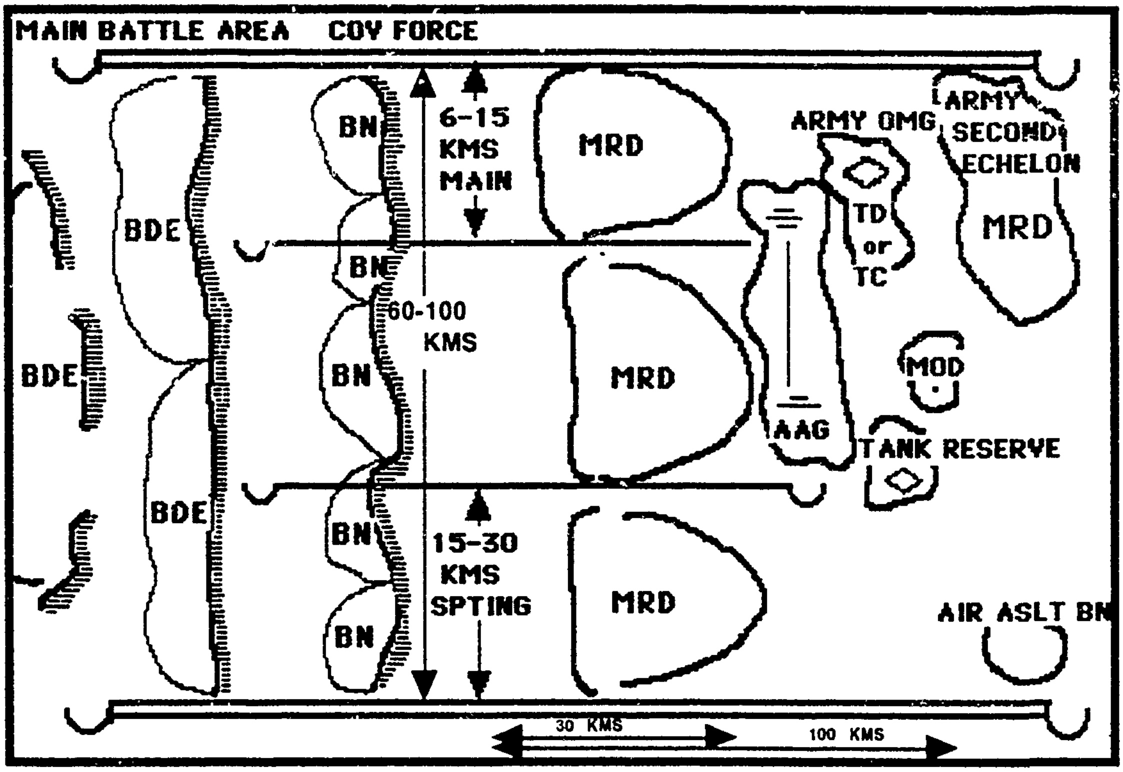
[21]Ibid., p. 39. [The SASO diagram has been adjusted to reflect the forward placement of the Army Artillery Group and the positioning of the CAA 2d echelon division generally to the rear of the main effort. This is consistent with current Western understanding of Soviet offensive (army) operations.]

achieve the requisite destruction of defending enemy forces so that the maneuver forces' probability of success is assured.

COMBINED ARMS ARMY OPERATIONAL FORMATION-AGAINST A FULLY PREPARED DEFENSE 1987



IMMEDIATE OBJ— 100 KMS
SUBSEQUENT OBJ— 250 KMS

[FIGURE 10]

A. G. Terekhov's September 1987 article in ***Voyennaia mysl'*** confirms that the Soviets perform iterative calculations of the correlation of forces for each army operation (as in Figure 10 above). In particular, he notes the calculation is performed at the start of the decision-making process, after the commander's decision is reached, and during the staff planning process. He outlines the need for calculating the overall COFM as well as the correlation for the main effort. He confirms the requirement for calculating COFM for "the more important moments in the course of mission fulfillment" which infers the need to repeat the COFM process during both preliminary planning and the actual execution of the operation.[22]

Ons of the simplest and most useful COFM equations in use by Soviet army commanders is the one (shown below) which expresses mathematical relationships among the overall COFM, the COFM on the main axis, the overall frontage of the operation, the width of the main thrust, and the minimum acceptable COFM off the main axis. This equation can be rearranged, as required, to find any of these five variables, given the other four.[23]

$$\boxed{V_{gl} = V \left[\frac{S - S_{dr}}{S_{gl} - S_{dr}} \right]}$$

<u>**Where**</u>:

* **S = Overall Correlation of Forces throughout the whole sector of operations**
* **S_{gl} = Correlation of Forces on Main Axis (breakthrough sector)**
* **V = Overall frontage of area of operations**
* **V_{gl} = Width of axis of Main Thrust (breakthrough sector)**
* **S_{dr} = Minimum permissable ratio of forces on other axes**

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[22]A. G. Terekhov, "A Methodology for Calculating the Correlation of Forces in Operations," *Voyennaia mysl'*, No. 9 (September) 1987, p. 56.

[23]A. E. Tatarchenko, "To the Question of the Creation of Strike Groups in Offensive Operations," *Voyennaia mysl'*, No. 5 (May) 1982, p. 55.

Another COFM-based formula available to the army commander for his planning is the one which calculates the required level of (enemy) destruction, given initial and required COFM and the forecast of (expected) enemy counteraction.[24] It is listed below. This particular equation has also been reduced to a nomographic decision aid to facilitate its rapid application during the planning of an operation. The nomograph is given later in this chapter.

$$\boxed{M = 100 - \frac{S_n}{S_t}(100 - P)}$$

Where:

M is the required level of destruction of the enemy as a percentage.

S_n is the initial correlation of forces of the sides.

S_t is the required correlation of forces of the sides.

P is the forecast of enemy counteraction (the expected level of destruction of own forces as a percentage).

The Combined Arms Army's (CAA) configuration in the defense is shown at Figure 11, below. Subordinate to the front, the CAA is arrayed in a security zone, a deeply belted first echelon, and a strong second echelon which contains both a reserve and counterattack force. The variation (20-30 kilometers) in normative frontage for each division reflects the army commander's flexibility in adjusting the frontal density of forces in his defense, consistent with his terrain analysis and enemy assessment. This helps him in

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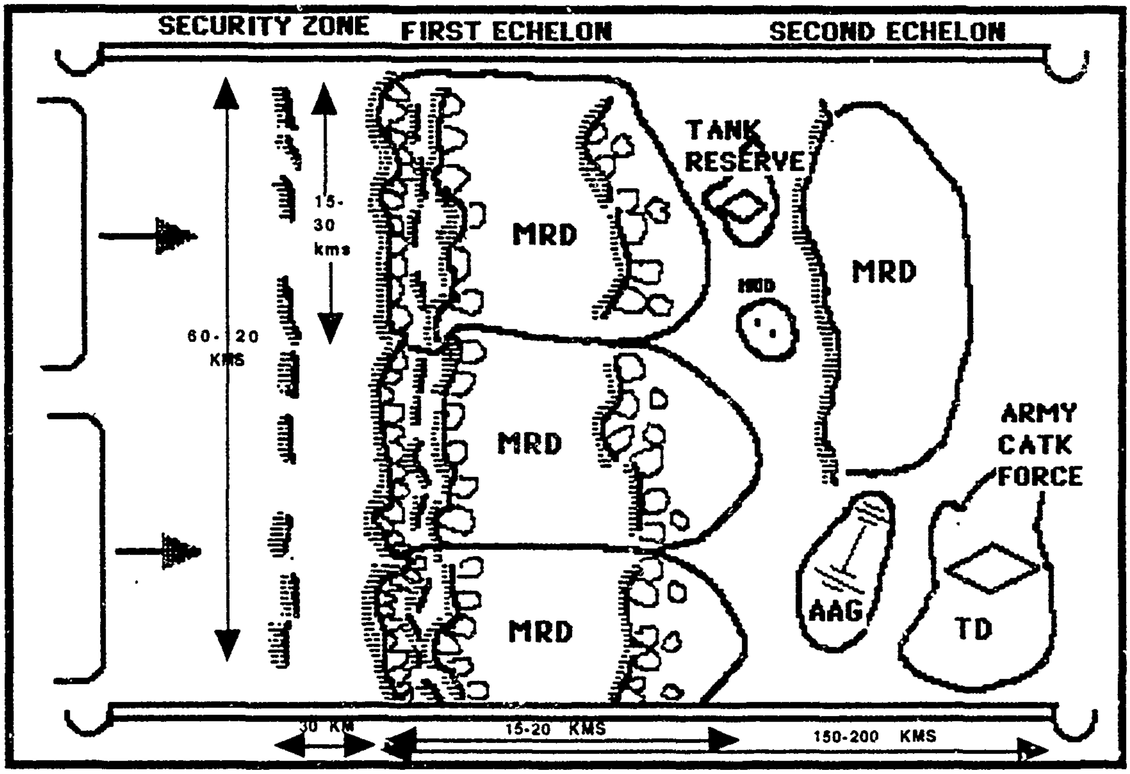
[24]Ibid., p. 56.

achieving an acceptable COFM on the most likely or threatening axes of enemy advance. His tank reserve is readily available for use in restoring a favorable COFM in the event of a localized breakthrough of his forward defensive belts. The counterattack force, usually a tank division, is poised to deliver a crushing blow along the flanks of the enemy and to regain the operational initiative when conditions (including the COFM of the combatants) become favorable.

COMBINED ARMS ARMY OPERATIONAL FORMATION- DEFENSE 1987

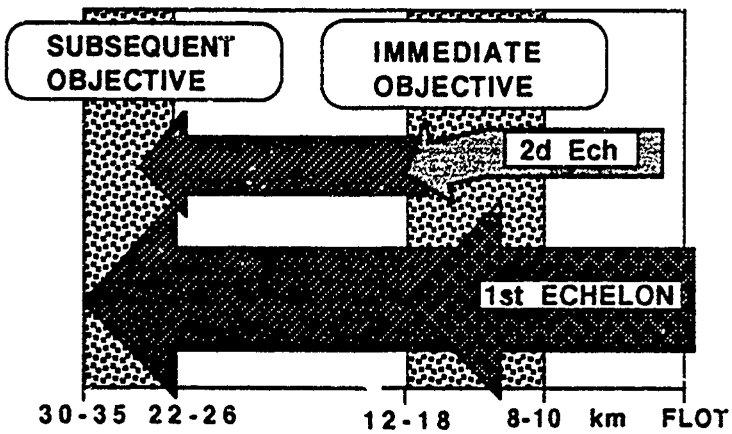


[FIGURE 11]

COFM IN DIVISION-LEVEL COMBAT

Under the control and direction of its parent army, the division conducts offensive and defensive combat in carrying out the higher headquarters' mission and intent. In the offensive, the division's array may take the form of one or more echelons and a variety of reserve and supporting forces. Typical objective depths for an army's first echelon division in a one-day operation are given in Figure 12, below.[25] The variety of COFM that may be required by the tactical commander for his decision process may well include: the correlation of forces through the immediate objective; the correlation through the subsequent objective; and force correlations both on and off the main attack axis.

DIVISION ONE-DAY OPERATION



[FIGURE 12]

Of course, the parent army commander specifies the missions for each first and second echelon division. That mission specification will include space-time objectives as well as minimum (enemy) and maximum (friendly) loss norms for the division's battles.

Armed with his mission taskings from the army commander, the division commander must make several decisions about the form and content of his impending combat actions. Among the more obvious COFM-based decisions would be: where and how wide will be the axis of the main strike grouping (main effort); the composition of forces allocated to the main and supporting axes; the placement of the anti-tank battalion and divisional reserve forces; the size, placement, and closure rate of the second echelon forces; whether to dispatch a forward detachment and where; the configuration of front, army, and divisional artillery battalions into artillery groups; and the amount of fire damage that must be achieved in the divisional zone to achieve a suitable degree of attack success probability.

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[25]Hines, p. 25.

A number of COFM-based tools are available to tactical (and operational) commanders to assist their combat (operational) planning and execution monitoring. These tools are discused as a grouping in the following subsection.

COFM-RELATED NORMS, TABLES, AND NOMOGRAPHS

As is evident in Soviet military literature, the time factor in battle and operations has become decisively important. Therefore, it is of the utmost necessity that the COFM methodology not be so rigorous or time-consuming that it delays or otherwise inhibits the decisionmaking process. Similarly, the COFM development process must not be so wedded to the Soviets' automated systems of control that their mechanical failure would preclude its rapid use in the decisionmaking process. Furthermore, since the smaller Soviet units and subunits (regiments, battalions, and companies) have so little time for battle planning and few (if any) computer systems to assist in their staff work, there arises a need for objective tools which facilitate the manual application of the COFM methodology.

According to Terekhov, the Soviets have developed a variety of norms and procedures that facilitate the characterization of combat action and the calculation of the correlation of forces. Norms are either derived from mathematical models or compiled from an information base of war experience. They are thought to characterize the mean conditions for the conduct of armed conflict and, therefore, are used to guide the commander's allocation of his resources.[26] Through use of these norms the Soviets have been successful in reducing certain elements of the COFM methodology to a manual system of charts, tables, and nomographs that aid the commander in both tactical and operational planning.

Soviet literature is replete with COFM-based decision aids. They range from matrices used in tabulating friendly and enemy combat potentials at

[26]Terekhov, pp. 54-56.

battalion and regimental level, to theater-wide graphs which relate COFM to general indices of force effectiveness. There appears to be no single, authoritative source document that prescribes the specific types of graphic decision aids that must be used; however, nearly every Soviet text on operational art, tactics, and troop control theory emphasizes their importance. Vayner's ***Tactical Calculations*** even outlines the process by which ***any*** military practitioner can construct nomographs for tactical use.[27] It is apparent that Soviet military science allows, even encourages, a certain degree of latitude in the development and use of objective tools for military decisionmaking.

Despite the diversity of decision aids advertised in Soviet literature, though, there remain three predominant themes: (1) that significant time savings may accrue from use of such tools; (2) that probability of success in operations can be assessed from an analysis of force correlations; and (3) that COFM has spatial implications. To illustrate these themes, several Soviet products are reproduced and discussed below.

Ivanov and others had in mind the reduction of ***tactical*** planning time when they suggested the use of ready-made forms, as exemplified in Figure 13. Quite obviously, some information can be entered in advance, so that only the variable conditions of the combat action remain to be entered.[28] Completing this form results in functional force correlations that, even in the absence of modeling, will support the commander's development of decision variants. This chart probably constitutes the extent that COFM calculations are carried out, at or below the division level, for non-nuclear combat.

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[27]A. Ya. Vayner, *Tactical Calculations*, 2d ed., rev. and supp., (Moscow: Voyennoye Izdatel'stvo), 1982. Translated by U. S. Air Force (FTD-ID(RS)T-1501-84), (AD-B091870), 21 March 1985, pp. 93- 100.
[28] Ivanov, p. 227.

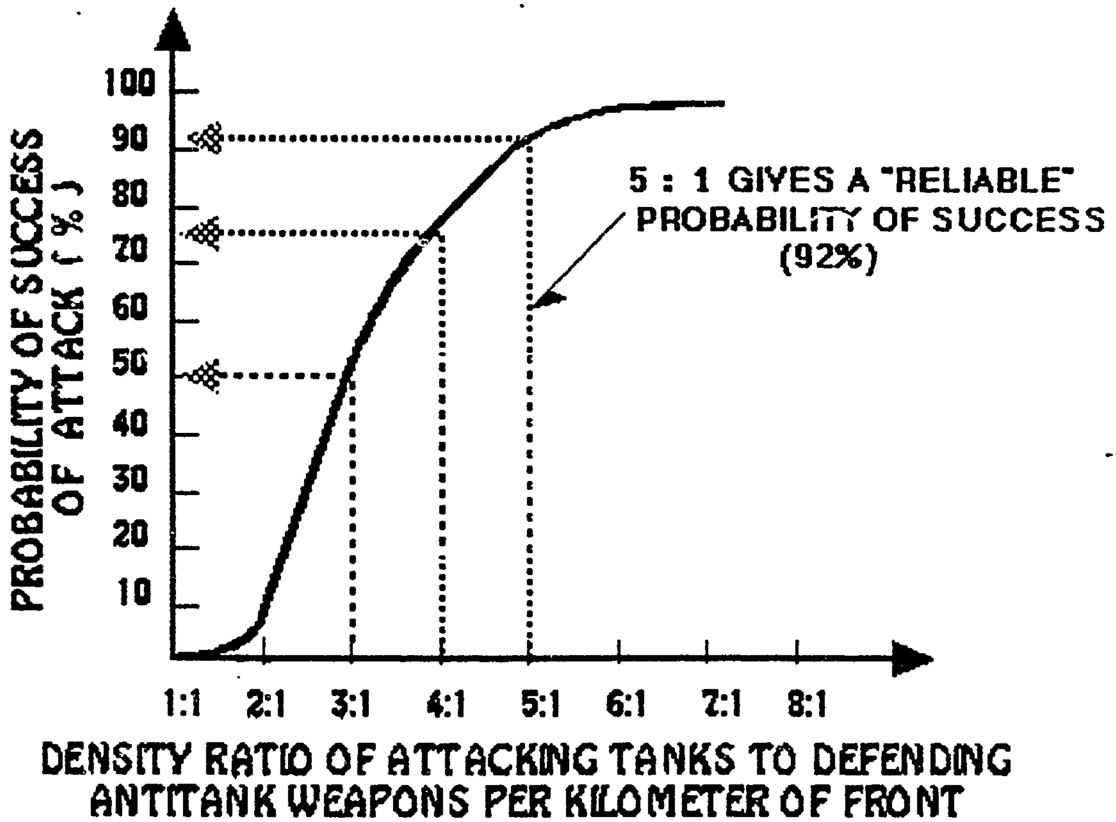
Force Correlation in the zone of advance _____ and the Mission Capabilities of the Belligerents With Respect to the Situation at _____ (the time)

List of men and equipment and the basic indices of the combat capabilities of the troops	Number		Ratio	
	Friendly Troops _____ (make-up)	Enemy Troops _____ (make-up)	Quantitative	Adjusting for quality (combat capability)
Total personnel, including the combat subunits of the motorized rifle (or motorized infantry) Co. Density per km ------------------------------ Tanks--total number, of which: medium- light- Density per km ------------------------------ Infantry combat vehicles and armored personnel carriers--total number Density per km ------------------------------ Artillery and mortars Total guns and mortars, those exceeding 100 mm Density per km Total area of destruction of exposed personnel per unit of fire (hectares) ------------------------------ Antitank weapons Total antitank units, of which: antitank guided missiles on AFVs-- portable antitank guided missiles-- antitank guns-- grenade launchers-- Density per km Total number of damaged tanks-- ------------------------------ Air defense resources Total firing units of which: antiaircraft missile system type-- antiaircraft guns (installations)-- Total number of air targets downed per attack-- ------------------------------ Motor vehicles and prime movers				

[FIGURE 13]

From a 1978 edition of the Soviet combined arms monthly magazine ***Voyenyy Vestnik*** (Military Herald), the author was able to derive the Soviet plot for attack success probability as a function of the correlation of forces using tank and antitank weapon densities (Figure 14, below).[29] The data for this particular graph was probably derived from historical battle analysis, aided to some extent by mathematical modeling. It appears directly related to Speshilov's phase two calculation of the correlation of tank and antitank forces, a sub-set of the overall correlation of forces.

ATTACK SUCCESS PROBABILITY AS A FUNCTION OF CORRELATION OF FORCES



[Figure 14]

[29]Yu. Kardashevskiy, "Plan the Destruction of Targets by Fire Creatively," *Voyennyy Vestnik*, No. 7 (July) 1978, pp. 64-67.

The Figure 14 example conveys the Soviet belief that one can discern the the probability of success (at least for tactical-level combat actions), given mean combat conditions, for functional groupings of weapons. Theoretically, a similar graph could be derived for indirect fire (artillery, guns, rockets, and mortars) systems; for the aviation-air defense correlation; and for the overall correlation of forces and means. These kinds of charts may also be meaningful at the operational level, where the average (or mean) densities of combatant forces are calculable. Here, the "law of large numbers" would tend to nullify the aberrations in opposing force densities, enabling the commander (or staff planner) to determine the mean expectation for success, either across the front or on the main axis.

In fact, the Soviets appear to be so convinced that the probability of attack success can be correlated to COFM, that they have reduced selected force superiority figures to norms for planning purposes. Figure 15 illustrates contemporary Soviet thinking about the necessary COFM, both on the main attack sector and for the force as a whole. The left two columns reflect historical analogies, while the right two columns are intended to convey norms for modern operational planning.[30]

The author believes that the reference to "self-propelled artillery" in row two refers to self-propelled anti-tank guns-- which were common to Soviet (and Western) forces during World War II --as well as to self-propelled artillery that was (and is) principally committed in the direct fire role. The chief Soviet "anti-tank artillery" weapons today-- towed T-12 / MT-12 anti-tank guns and self-propelled BRDM-2's equipped with anti-tank guided missiles (ATGM) --are likely included in this category. Other, infantry-portable ATGM may be counted in the second category, as well. Soviet 2S1 and 2S3 howitzers allocated for

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[30]Phillip A. Peterson and Notra Trulock III, "Equal Security: Greater Stability at Lower Force Levels." Proceedings of a seminar for permanent and military representatives to NATO and sponsored by the U.S. Mission to NATO: *Beyond Burdensharing-- Future Alliance Defense Cooperation*, 12 December 1988, in Brussels, Belgium, (April 1989), p. 73. [Peterson and Trulock cite their source for this material as "Lecture Materials from the Voroshilov General Staff Academy, Army Offensive."]

use in the direct fire role would definitely be included. Row three is believed to include all the various forms of tube and rocket artillery, guns and mortars, and surface-to-surface missiles to be used in the indirect fire role. Towed ***and*** self-propelled systems used for ***indirect*** fire are likely included in this category. The "aircraft" category probably includes all the fixed- and rotary-winged attack aircraft dedicated to the ground support role: bombers, fighter-bombers, attack helicopters, and the like. One can readily see that the chart's functional arrangements bear some resemblance to Speshilov's groupings-- as discussed in Chapter 3 of this thesis.

CORRELATION OF FORCES IN MAIN ATTACK SECTORS AND SECONDARY (ACTIVE/PASSIVE) SECTORS

(Indicated as Relative Superiority over Opponent. X:1)

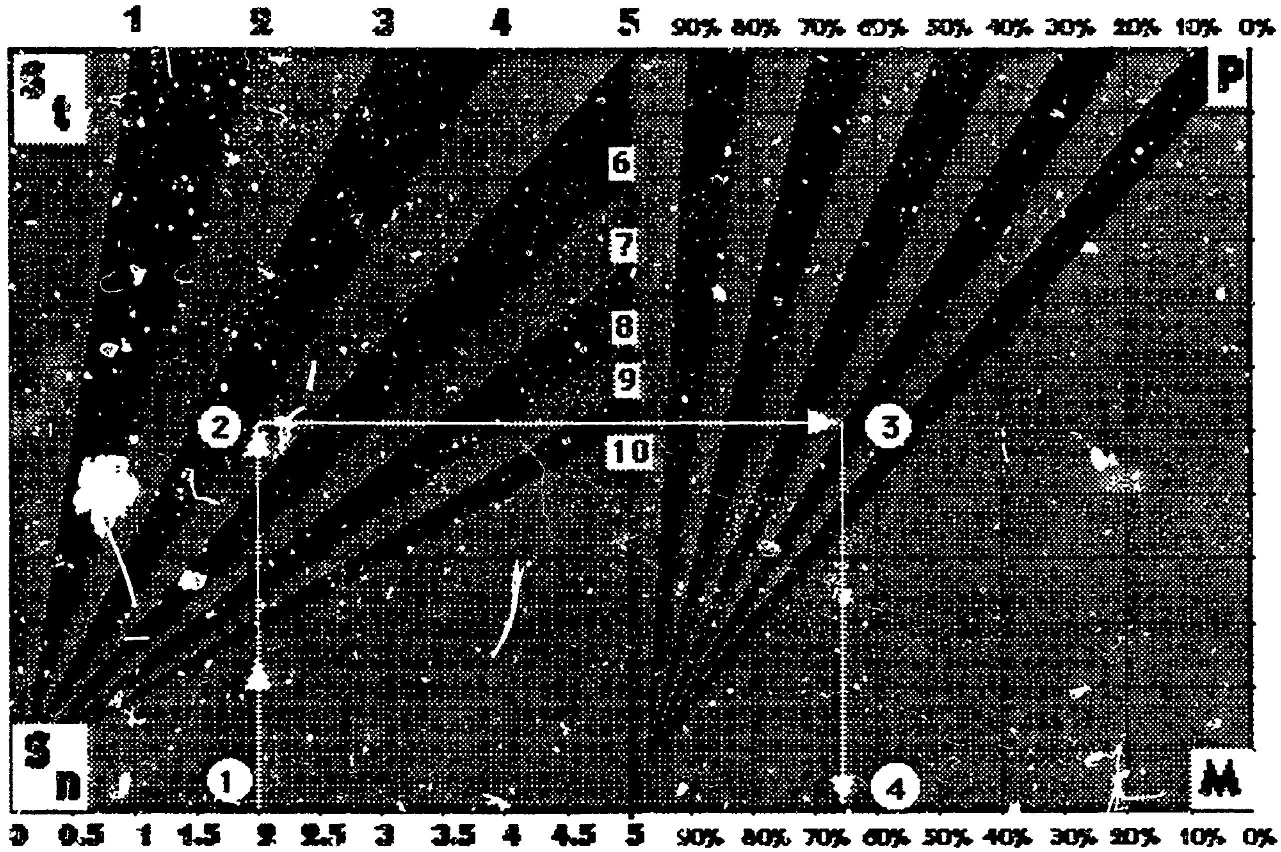
	LAST Ops of WWII		Concepts of 1945-1953		With Nuclear Employment		Without Nuc Employment	
Forces and Means	General	Main Sector	General	Main Sector	General	Main Sector	General	Main Sector
Motorized Rifle Battalions	1.4-5.5	3.0-8.5	1.1-1.5	3-4	1.0-1.5	2-3	1.0-1.5	3-4
Tanks and Self-Propelled Artillery	1.1-6.0	4.5-9.0	1.5-2.0	3-4	1.0-1.5	2-3	1.0-1.5	3-4
Artillery	1.5-6.5	4.2-8.5	1.5-2.0	3-4	1	1.5-2.0	1.0-1.5	3-5
Aircraft	2	3.5	1.5	2	1	1	1.5	2

Source: "Lecture Materials from the Voroshilov General Staff Academy, Army Offensive"

[FIGURE 15]

Frequently, the Soviets use norms and COFM calculations together in a single nomograph. Illustrating this is the nomograph for determining one's required level of (enemy) destruction-- Figure 16. It represents the reduction of the formula for "required level of destruction" discussed under the heading COFM in Front and Army Operations, above.[31]

REQUIRED LEVEL OF DESTRUCTION



Where:

S_n -- initial correlation of forces of the sides

S_t -- Required correlation of forces of the sides

P -- Forecast of enemy counteraction

M -- Required level of destruction as a percentage

[Figure 16]

[31]Tatarchenko, pp. 57-58.

The circled numbers and arrows superimposed on the nomograph signify the four-step process by which it is used. **Step 1**-- the calculated (overall) correlation of forces marks the starting point on the left-side matrix. In this example, the value is 2.0. **Step 2**-- a vertical line is extended until it intersects with the line corresponding to the required correlation of forces for combat. (Note: the required correlation is as specified by higher headquarters or determined by normative evaluation by the commander.) In the example above, the required correlation is 4.0. **Step 3**-- a horizontal line is extended to the right until it intersects the line corresponding to the expected enemy counteraction (fire damage to friendly units) on the right-side matrix. In this example, the expectation is 30% damage. **Step 4**-- a vertical line is extended downwards until it intersects the bottom edge of the nomograph, thereby identifying the percentage (degree) of fire damage that must be delivered upon the enemy. In this case, 65%.

Some Soviet charts are created directly from mathematical modeling, under specific operational conditions, where the outcomes are the probability of success and the mathematical expectation of losses among the belligerents. Such is the case in Figures 17 and 18, below, where the Soviets illustrate the correlation of forces in a sector of the Odessa defensive operation of September, 1941.[32] This kind of modeling (and graphic representation) is likely being performed to help the commander determine his optimal artillery (indirect fire) allocations and the optimal strip width for his counteroffensive.

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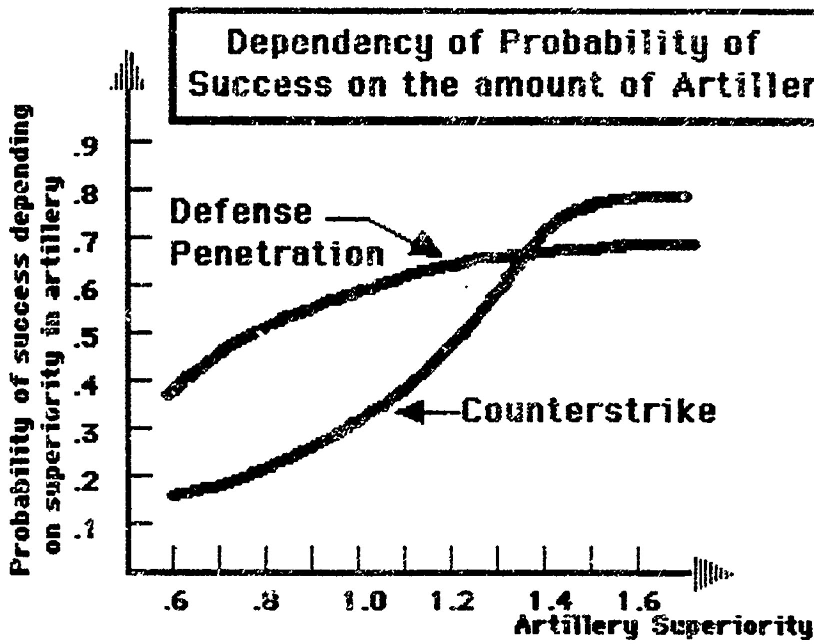
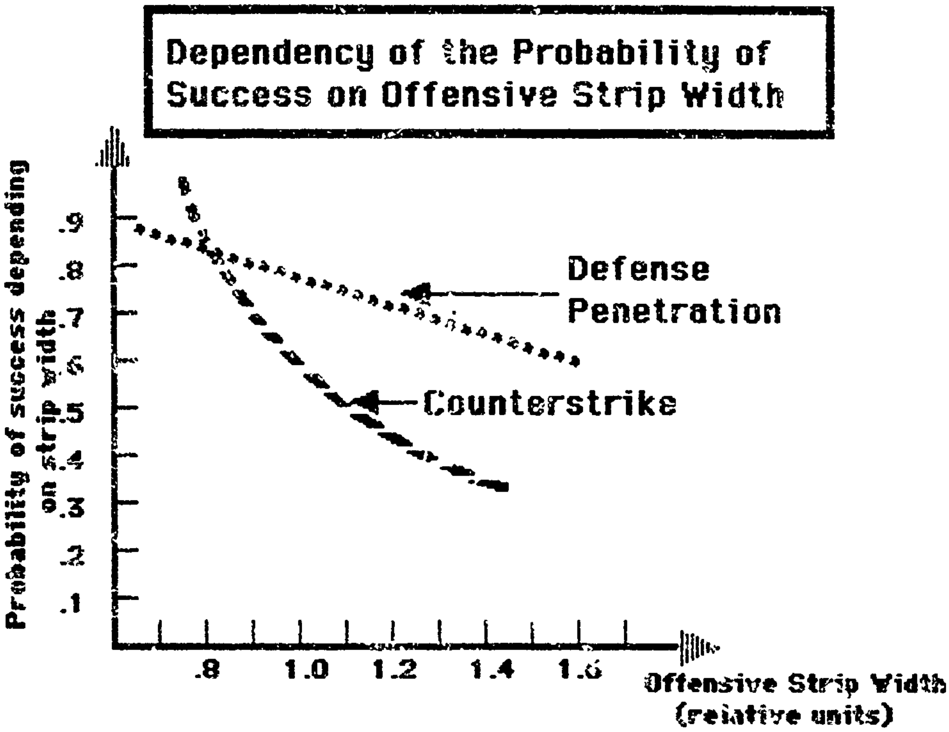
[32]Tarakanov, pp. 317-331.



[Figure 17]

Noteworthy in the Figure 17 diagram is the relationship between the correlation of artillery forces and the probability of success. Two curves are developed as determined in the mathematical model. The "defense penetration" curve reflects the probability that his maneuver force will penetrate the enemy's defenses given varying levels of artillery superiority. The "counterstrike" curve plots the probability of success in achieving the required degree of enemy destruction for varying artillery correlations. Hence, the graph is meant to quantitatively express the fundamental dependencies of friendly maneuver and enemy destruction on indirect fire superiority.

Figure 18 uses the same modeling approach for identifying the fundamental relationship between the offensive strip width of the counterstrike and its probability of success. In this example, force correlations in the offensive strip are not directly reflected, but they *are* a determining factor in the shape of the curves. In other words, the offensive strip width determines how concentrated the allocated forces will be in the counterstrike, relative to the defending enemy. Most noteworthy (and intuitively consistent) is that, for increasingly greater strip width, there is a sharply decreasing probability that the counterstrike will achieve the required enemy destruction. Similarly, the likelihood for penetrating the enemy's defenses declines with ever wider offensive frontages.[33]



[Figure 18]

Charts like Figures 17 and 18 may be invaluable to the operational commander during his planning process. They provide quick reference for the probability of success in varying conditions of impending operations. They reflect "points of diminishing returns"-- specifically, the points beyond which further force allocation yields little (if any) increase in success probability. But perhaps most importantly, they may graphically assist the commander in "balancing" his available forces for optimal employment.

The experience of the Great Patriotic War and extensive post-War modeling and analysis have led the Soviets to the conclusion that COFM has spatial connotations. The Soviets have reduced their kinematic modeling

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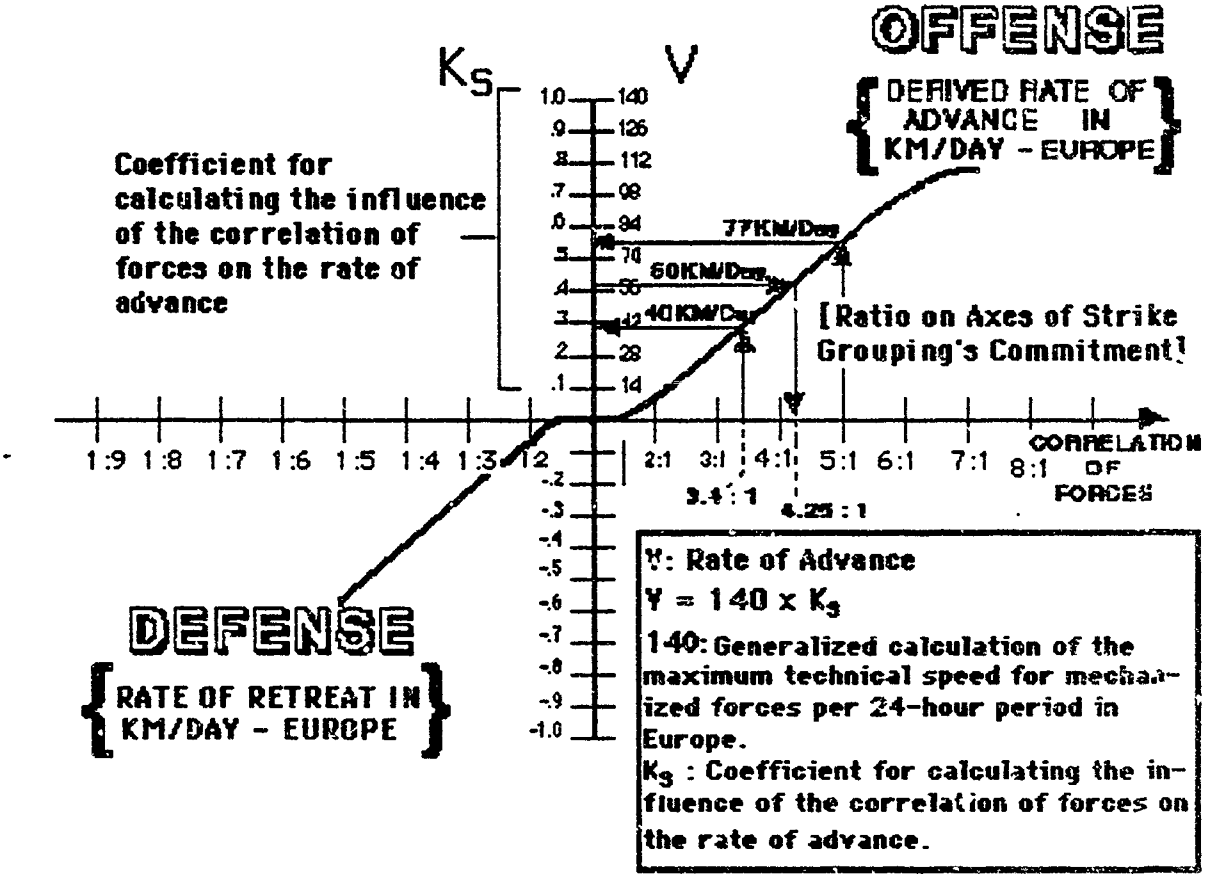
[33]Ibid.

results into descriptive graphs which plot the rate of advance (or retreat) for force groupings as a function of their degree of force superiority. Figure 19 is one such graph. It depicts the "strike grouping's" superiority (i.e., on the main effort) and relates its correlation of forces to the rate of its advance. Interestingly, 140 kilometers per day is given as the maximum theoretical rate at which the Soviets believe they might advance in Europe.[34]

THE RATE OF ADVANCE IN EUROPE AS A FUNCTION OF THE CORRELATION OF FORCES



[Figure 19]

[34]Tatarchenko, pp. 58-59.

SUMMARY

This chapter has demonstrated the prevalence of application that COFM has in Soviet operational and tactical decisionmaking. Because the Soviet decisionmaking process reinforces the use of objective factors in arriving at decision variants, and because it focuses on objective measures of effectiveness in substantiating the "most correct" decision, the COFM methodology is well-suited for use. The influences of COFM on operational and tactical planning are reflected in current methods for configuring forces, assigning objective depths, and partitioning frontages and depths of employment. In fact, COFM has become so well refined in Soviet military science, that it has become intertwined with other factors of military art in the form of planning and decisionmaking norms.

The author has provided tables, charts, graphs, and nomographs which are used in various ways, and at different levels, in Soviet military decisionmaking and planning. These tools reflect three characteristic themes: that planning and decisionmaking time can be saved through their use; that probability of success can be directly associated with force superiorities; and that COFM has spatial implications. However disagreeable these themes may be to Western military thinking, they are of significant importance in Soviet military affairs.

History reflects a long-standing dispute among military theoreticians as to the proper role that quantitative methods have in determining the outcome of armed conflict. Because COFM is a quantitative method, it comes as no surprise that its use would be the subject of some controversy. Indeed, even in the Soviet Union it has met with harsh criticism over the past fifteen or so years. Suffice it to say, there is far from universal acceptance of the COFM methodology, in its present form, even in the USSR. Some of the more important issues surrounding COFM's derivation and its utility in operational and tactical decisionmaking are discussed in Chapter 5, "Strengths and Weaknesses of the COFM Methodology."

CHAPTER 5

STRENGTHS AND WEAKNESSES OF THE COFM METHODOLOGY

There are many who will be inclined to cavil at any mathematical or semi-mathematical treatment of the present subject, on the ground that with so many unknown factors, such as the morale or leadership of the men, the unaccounted merits or demerits of the weapons, and the still more unknown "chances of war," it is ridiculous to pretend to calculate anything. The answer to this is simple: the direct numerical comparison of the forces engaging in conflict or available in the event of war is almost universal....[1]

F. W. Lanchester

As alluded in Lanchester's above quotation, the student of military art and science will find that few (if any) strategic, operational, or tactical theories or methodologies ever achieve universal *acceptance*, even if they are in near-universal *demand*. Moreover, their successful implementation by one army frequently does not signal the appropriateness for use among other armies. Of course, the theory (or methodology in the case of COFM) must be complementary to an army's techniques and procedures, and compatible with its doctrine, if it is to be successfully employed. This should not deter one, however, from examining the merits of another's ways and means of conducting operations and battles. If for no other reason, such study will lead to a stronger appreciation of one's potential adversaries' abilities and their (potentially) exploitable weaknesses.

Having established the lineage, theory, and operational-tactical applications of the COFM methodology, it is now possible to provide a critical review of COFM's apparent strengths and weaknesses. This brief review of COFM includes a discussion of both theory and application so that the reader

[1]Frederick W. Lanchester, "Aircraft in Warfare: The Dawn of the Fourth Arm, Pat. V-- The Principle of Concentration," *Engineering*, 2 October 1914, p. 46.

may ponder the merits of quantifying the battlefield for purposes of decisionmaking. Exploitable vulnerabilities arising from COFM's use are less evident, but distinct weaknesses are mentioned; weaknesses that might well lead to battlefield vulnerability.

STRENGTHS OF THE COFM METHODOLOGY

It must first be made clear that the Soviets do ***not*** rely solely on quantitative methods, such as COFM, in military decisionmaking. Chapters 2-4 should have reinforced the Soviet idea that not all battlefield and troop conditions are yet quantifiable; and that, even if they were, the enemy's tactical and operational methods for employing his forces would necessarily require the Soviet commander to use heuristic judgement in choosing an optimal decision variant. For example, the Soviets possess an abiding appreciation for potential enemy use of surprise and deception in operational matters; an ability that is virtually unquantifiable. They are, themselves, creative practitioners of ***maskirovka***-- which seeks to manipulate the enemy's perceptions about Soviet tactical and operational capabilities and intentions --the effects of which are difficult to measure. **In short, mere numbers do not drive the Soviet decisionmaking process; but they *do* provide the necessary substantiation for the selection of a decision variant, and they are the basis for further planning of an operation.**

Couched in this perspective, certain categorical aspects of the COFM methodology seem to reflect distinct merit. First, COFM owes its lineage to the historical study of war and armed conflict. It is deeply rooted in the documented outcomes of large-scale conflicts; particularly, World Wars I and II. Second, COFM is of significant use in military decisionmaking, particularly at the operational level. Third, it complements rather than counteracts Soviet military art. And last, it is ideally suited for use in arms control negotiations. Each of these attributes deserves elaboration.

Historical Significance. As early as 1915, M. Osipov developed his "theory of losses" from a study of 38 conventionally-fought battles and campaigns spanning 100 years (1805-1905).[2] His observations revealed a certain correspondence between the strengths of the opposing sides and their respective losses. His mathematical equations relating this phenomenon bore a strong resemblance to Lanchester's differential equations, which were published at about the same time.

To make his theory practicable, Osipov used what the Soviets now call the "method of compensation" to measure the fire potential of the opposing forces. He arrived at non-dimensional, "numerical coefficients" for each of the various types of forces (infantry, artillery, and machineguns) which corresponded to their contributions in killing enemy infantry.[3] Osipov then summed the theoretical potentials for the combatants and applied his formulae to determine the theoretical losses that would accrue. His calculations were in general agreement with the actual outcomes in most all of the battles he studied.

Osipov admitted some misgivings about deviations in the actual (versus predicted) outcomes, which he attributed to "random and systematic errors."[4] Random errors were thought to include the influence of such factors as skillful leadership, the morale of the troops, the relative superiority of artillery and machineguns, quality of armament, and means of troop protection.[5] Systematic errors included the influence of terrain, fortifications, the tactics of the combatants, and variations in the opponents' troop densities.[6] In short,

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[2]M. Osipov, "The Influence of Numerical Strength of Engaged Sides on Their Losses," Part I, *Voenniy Sbornik*, June 1915. Translated by Robert L. Helmbold, March 1985, p. 1.1.

[3]Ibid., p. 4.1.

[4]M. Osipov, "The Influence of Numerical Strength of Engaged Sides on Their Losses," Part II, *Voenniy Sbornik*, July 1915. Translated by Robert L. Helmbold, March 1985, p. 7.2.

[5]M. Osipov, "The Influence of Numerical Strength of Engaged Sides on Their Losses," Part III, *Voenniy Sbornik*, August 1915. Translated by Robert L. Helmbold, March 1985, pp. 7.3-7.11.

[6]M. Osipov, "The Influence of Numerical Strength of Engaged Sides on Their Losses," Part IV, *Voenniy Sbornik*, September 1915. Translated by Robert L. Helmbold, March 1985, p. 7.19.

Osipov's work was far from comprehensive in quantifying the battlefield. However, his early work in quantitative battle analysis paved the way for more exacting Soviet work in the decades ahead.

As discussed in Chapter 2, a variety of Soviet theoreticians have sought to relate mathematics and military affairs throughout the 20th Century. Their studies were stimulated in large measure by the two world wars, as well as by other large-scale conflicts: namely, the Arab-Israeli Wars of 1967, 1973, and 1982; the American experience in Korea; and their own Russian Civil War. From the mass of data collected over this century, the Soviets have been able to refine and improve Osipov's early work and to extend it beyond mere (retrospective) battle analysis.

Benefiting from the immense volume of data from operations and battles during the Great Patriotic War, the Soviets were able to deduce fundamental dependencies between opposing force correlations and the sides' eventual troop and materiel losses. Moreover, they uncovered the means-- namely, the COFM technique --for relating force correlations to relative rates of advance, enemy force attrition, and probability of success. Emerging military-mathematical theory was applied for purposes of forecasting battle outcomes and optimizing the employment of men and materiel in operations. The advent of Venttsel's 1960's work on operations research marked the turning point for contemporary military use of quantitative methods.

The last 25 years have witnessed a plethora of Soviet literature espousing the usefulness, indeed the necessity, of substantiating military action through use of numbers. This fervor has attracted some of the finest mathematical and military-historical minds in the Soviet Union, and it seems to have no bounds. Some of the most recent editions of the the highly regarded Soviet staff journal, ***Voyennaia mysl'***, seem to indicate the Soviets are pressing military objectivity and optimization to their natural limits-- essentially, the limits of mathematical theory. One Soviet author even suggested that the Soviet theory of war and military art be removed from the subordinate control of its governmental (military) organs, and placed under the supervision of the

Academy of Sciences; this to achieve equal status among Soviet social sciences. He felt that such action would raise Soviet military science to an even higher plane.[7]

In short, the Soviet propensity for military-mathematical methods is the result of more than 75 years of purposeful study, self-criticism, and refinement. Soviet operational and tactical commanders are the beneficiaries of the best that Soviet military historians and mathematicians have had to offer. That Soviet military science has put to use all these years of research, has to be considered a strong argument on behalf of COFM's utility in operational-tactical decisionmaking. And the quest goes on.

Aid to Decisionmaking. The primary task of Soviet troop control is, as has been discussed, decisionmaking. (The same may be said about command and control in the U. S. Army.) It is the operational decision that commits divisions and armies in such manner as to achieve assigned tasks (missions). Because operational decisions must be made during the turbulent ebb and flow of the conflict-- when time is of the the essence and force survivability requires almost clairvoyant skill of the commander --the roles of objectivity and optimization in the process take on special significance. The fewer the conditional variables the commander has to consider, the simpler the tools he has to use, the faster he can choose the forces and means that are to be employed, the more efficient will be his troop control process.

The COFM methodology makes this possible in the Soviet troop control system. The correlation of functional groupings of weapons gives tactical and operational commanders a general appreciation for the course and outcome of their battles (operations). Static COFM estimates help <u>front</u> and army commanders make operational decisions. They give them general appraisals for probability of success and relative rates of advance. In combination with dynamic or kinematic modeling, COFM tells the commander how his options

[7]B. A. Kokovikhin, "Mathematical Modeling of Military Operations," *Voyennaia mysl'*, No. 12 (December) 1987, pp. 39-40.

(decision variants) might "play out," giving him an objective basis for choosing one over another. Dynamic COFM calculations can be generated for various times in the operation. They can signal the need for subsequent operational decisions-- when and where to commit second echelon or reserve forces, for example.

But perhaps most importantly, COFM affords the ability to apportion the commander's forces so that they will be optimally employed, at the right time and place and in the right numbers, to ensure a high probability of mission accomplishment.

It does all this in a relatively short period of time during the operational decisionmaking and planning processes. Static COFM computations require but a few minutes to tally. Automated databases, manipulated by rather simple algorithms may be used by the operational commander to obtain a snapshot of his quantitative combat potential. They help him to eliminate infeasible decision variants and to apportion forces. The computer is used to verify the commander's decision variant through objective evaluation of the likely enemy destruction, friendly force preservation, and rate or degree of advance. Finally, the operational plan is worked out in detail. Key requirements-- such as subordinate unit tasks, coordination required, integration of air and ground fire strikes, etc. --are determined with the help of COFM calculations and kinematic modeling of the resulting plan.

Complements Soviet Military Art. Given the Soviet focus on objective planning and decisionmaking, COFM is well-suited to ***and*** well-integrated in their military art. The Soviet penchant for norms and measures of effectiveness almost demands objective tools like COFM for purposes of assigning tasks, establishing objectives, and determining where to locate the main effort.

In the Soviet view, the use of quantitative methods does not mean prescriptive or stereotypical execution of operational and tactical missions. Quite to the contrary, it is precisely their use of COFM and mathematical modeling, in support of decisionmaking, that affords flexibility and creativity in the planning and execution of those operations. COFM diminishes the amount of time required for subjective assessment of the battlefield situation. It helps to highlight exploitable enemy vulnerabilities. It quantitatively expresses the inherent advantages of one decision variant over another. It actually reduces the commander's burden, freeing him to contemplate creative techniques for achieving the enemy's destruction, to perform a personal reconnaissance of the battlefield, and to monitor his forces' preparation for combat.

Arms Control Advantages. Although not within the scope of this paper, arms control is becoming a dominant theme in the military-political arena. Because COFM has distinct potential for use in arms control, it is briefly discussed, here, in that light.

In March 1989 one Soviet theorist, Vitaly Tsygichko, suggested the joint U.S.-U.S.S.R. use of force correlations for purposes of reducing conventional arms in Europe.[8] His methodology, a parallel system to that used in Soviet operational-tactical troop control, was aimed at objective measurement of the worth of various combat systems (and units). By using mathematical models of combat operations, Tsygichko suggested that the two countries could assign combat potentials for each weapon (and force) in their European arsenals. The mathematical model would determine the resulting force ratios (i.e., their COFM), thereby providing an objective starting point for talks. There is little doubt but that the Soviets' reasoning was logical and rational.

However, their 25-plus years of refinement of the COFM methodology puts the Soviets at a distinct advantage over their U.S. counterparts. Despite the U.S.'s superiority in computer hardware and software, and its vast experience in defense-related computer simulation, it has had little experience in mathematically modeling combat or operations for purposes of calculating the combat potentials of dissimilar systems or assessing force ratios. No doubt,

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[8]Vitaly Tsygichko, "Combat Potential Method for Vienna Talks," *Voennyi Vestnik*, (Military Bulletin), No. 5 (59), March 198?, pp. 7-13.

the Soviets recognize the U.S. weakness. The only doctrinal text even resembling the Soviet COFM in U.S. use is Fort Leavenworth's Student Text 100-9 (Command Estimate), a pedantic methodology, at best. Most certainly, the Soviets have read it.

Should the U.S. choose to accommodate the Soviets, the results at Vienna will be interesting. (One might liken it to playing chess with a grand master, shortly after reading a book on the subject; but here, the stakes are far more serious.)

WEAKNESSES OF THE COFM METHODOLOGY

As with all military methodologies and techniques, COFM has its limitations and shortcomings. One of the more obvious limitations is the simple fact that one simply cannot quantify all elements of the battlefield. The Soviets recognize this shortcoming, but that does not deter them from their quest for battlefield objectivity; nor should it. Other noteworthy criticisms of the COFM methodology include: the sufficiency of operational models in which COFM is used; COFM's dependence on battlefield information; the inevitability of contradictions in its use; lack of uniform application of the methodology at all levels of military art; and its limited use in other than conventional conflicts. These inadequacies are discussed below.

Limits to Quantification. Intuitively, most military practitioners recognize there are reasonable limits to applying numerical methods in combat (operations). Soviet theoretical work throughout the 1960's and 1970's seemed to stretch things a bit. For example, in 1965, V. N. Zhukov and others professed that, A qualitative factor-- troop training --can also be expressed quantitatively with the aid of numerical indices such as firing speed, firing accuracy, time of completing certain operations, etc.[9]

Some eight years later P. N. Tkachenko correctly reasoned that certain qualitative characteristics of troop units (morale, resistance, discipline, quality of cadres, presence of control systems, etc.) could not be accounted for quantitatively. However, that did not deter him from (incorrectly) suggesting the cumulative influence of such factors:

> Their total effect on the outcome of combat operations can be estimated in first approximation using general combat efficiency loss coefficients which are determined with the aid of statistical methods. On the average for troops with good morale... .4-.5 is used, for demoralized troops... .7-.8 [is used].[10]

No doubt, there remain some Soviet theorists who hold to the notion that most all qualitative battlefield and troop factors can, in some way, be quantified. But it appears the majority opinion is as cited by Strel'chenko and Ivanov in 1987:

> ...military might has objective and subjective factors. Armament and equipment are objective...moral quality of troops, political training, psychological preparation, training of troops, and training of commanders and staffs are subjective....Presently, we cannot evaluate the quality of subjective factors and these are done heuristically.[11]

The establishment and aggregation of combat potentials for armament, then, appear to be the crux of objective evaluation; but even that is arguable. As discussed in Chapter 3, determining combat potentials for armament is

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[9]V. N. Zhukov, *Mathematics in Combat*, (Moscow: Military Publishing House), 1965. Translated by U.S. Army Foreign Science and Technology Center (FSTC-HT-23-852-71), (AD737149), p. 70.

[10]P. N. Tkachenko et al., *Mathematical Models of Combat Operations*, (Moscow: Sovetskoe Radio), 1969. Translated by U. S. Army (FSTC-HT-23-270-73), (AD764109), 26 April 1973, p. 119.

[11]B. I. Strel'chenko and Ye. A. Ivanov, "Some Questions About Evaluating Force Ratios in Operations," *Voyennaia mysl'*, No. 10 (October) 1987, pp. 55-56.

theoretically possible (if using a mathematical model), but the values assigned are conditional; i.e., purely a function of the model's parameters. The closer the model is to simulating actual combat (operational) processes, the more accurate are the derived values for armament. Still, no model in existence, today, portrays all the exigencies of modern all-arms combat. Most large-scale (stochastic) models-- those required for simulating heterogeneous troop groupings --don't even give discrete treatment of individual systems and their interaction with unquantifiable battlefield factors. The evidence seems conclusive: one cannot determine a universally applicable unit of combat potential. The Soviets appear to appreciate the limitations imposed by that shortcoming:

> Now, and in the near future, in the course of determining the potential of forces for various missions, it will be more expedient to harmonize the necessary correlation of forces for the sides after calculation of the forces and for each basic military system. There is no sense in comparing dissimilar systems such as SAMs and ATGMs which do not fight each other.[12]

Model Sufficiency. Aside from the already mentioned pitfalls in assigning combat potentials from computer-based modeling, there are other model limitations that may cause COFM computations to go awry. These limitations include: sufficiency of the model's mathematical equations and algorithms; the level of force aggregation for modeling; the model's inability to portray other than stereotypical enemy and friendly tactics; and that ever-present constraint of time.

The first limitation stems from the use of complex mathematical equations: they only approximate the processes of combat. Lanchester-based differential equations, for example, are popularly used in idealizing the combat attrition process. They are widely applied in both Soviet and U.S. models. However, despite their popularity, they have definite drawbacks. As Joshua Epstein notes:

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[12]A. G. Terekhov, "A Methodology for Calculating the Correlation of Forces in Operations," *Voyennaia mysl'*, No. 9 (September) 1987, pp. 53-54.

...although directed at the right questions, the ***Lanchester equations offer a fundamentally implausible representation of combat*** under all but a very small set of circumstances....[13]

Epstein's criticisms of Lanchester-based equations include: (1) they do not reflect lower attrition when a unit withdraws (i.e., is partially or entirely out of contact); (2) they give no credit for trading battlefield space for time (i.e., constant attrition is rendered to a unit regardless of its tactics); and (3) they do not allow for diminishing marginal returns (i.e., the attacker's concentration of forces is never moderated). Of all the U.S. attempts to "fit" Lanchester's theoretical laws to battle outcomes, only one has ever been successful-- the battle of Iwo Jima. And that was a special case, according to Epstein.[14]

Of course, this singling out of Lanchester is unfair. ***All*** mathematical equations (and models) fall short of simulating the actual combat processes. They are, after all, only approximations of the actual combat interaction. They simply cannot convey the vagaries of combat, the complex interaction of men and materiel in pursuit of assigned tasks.

Force aggregation is another shortcoming attributable to many models. The broader the scope of the simulation, the greater the need to aggregate forces. This poses a problem for COFM in that the intricacies of combat performance among individual systems and small units is lost; rolled up into a larger formation's combat capability. Attempting to model the offensive operation of a Soviet front or army may well require the aggregation of all forces up to regimental level. Indeed, Terekhov seems to infer such practice: "In modeling the battle in the tactical zone, equal weight is given to the correlation of forces of divisions and regiments in the area."[15] None of the author's source documents clearly establishes the level of aggregation common to Soviet

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[13]Joshua M. Epstein, *The Calculus of Conventional War: Dynamic Analysis Without Lanchester Theory*, (Washington, D. C.: The Brookings Institute), 1985, p. 4.
[14]Ibid., pp. 8-9.
[15]Terekhov, p. 57.

operational models, but time and simplicity would seem to dictate an aggregation to at least regimental level.

Another characteristic shortcoming of using mathematical models is the simplicity in which friendly and enemy tactics are portrayed. This is characteristic of most all stochastic and deterministic models. Most of them are not interactive-- they run without interactive (human) decisionmaking. Algorithms, instead, drive the model. Therefore, the sufficiency of the model depends on the sufficiency of its decision algorithms-- most of which greatly oversimplify the movements and fires of the combatants. Changes in the correlation of forces, as tabulated from these models, will not reflect all the influences of actual combat. But, because the "law of large numbers" applies, statistically, to operational conflict, the outcome of the model reflects the mean expected outcome of the actual conflict. In other words, random deviations in performance among the small units tend to cancel each other out in their effects on the overall operational outcome.

A final model sufficiency problem is that of time. Chapter 2 highlighted the Soviet emphasis on the "time factor in battle." The entire Soviet troop control apparatus revolves around optimal use of available planning and execution time. COFM, itself, is intended as a time-saving tool. But the models which produce dynamic and kinematic COFM also require a lot of data loading and operating time. The Soviets continually stress their need for reducing the time it takes to gather information and load it in the computer. Further, their apparent need for computing COFM repetitively-- for different times and locations during the operation --places a high premium on the small amount of available planning time.

The commander's decision requires staff responsiveness in modeling so, naturally, fast models will be preferred. The need for fast modeling, though, introduces the problems already mentioned: the need for more aggregation and simpler and fewer decision algorithms. Moreover, if the staff model is stochastic, several iterations must be performed to ensure the outcomes are statistically reliable. (For some large-scale models, up to 30 runs of the same operation may be required for good confidence.) But even stochastic models only yield approximate solutions to the course and outcome of armed conflicts. Therefore, in the interest of saving time, the Soviets likely use deterministic staff models-- containing partial differential equations in the computer algorithms --to support operational and tactical decisionmaking.

Information Dependence. One never has all the information he needs for truly optimal decisionmaking. Such is the nature of armed conflict. But this does not diminish the requirement for deciding ***how*** to commit ***which*** forces, ***when*** and ***where*** they will achieve the greatest success, and in ***what*** way. The COFM methodology seeks to assist the Soviet commander in resolving his decisions, but its usefulness is strictly dependent on the accuracy of its information. Because COFM is a model of sorts, it is subject to that venerable modeling adage: garbage in; garbage out.

One ***must*** know the numbers and types of enemy forces if he is to correlate them to his own forces. COFM requires the foreknowledge of the enemy's troop dispositions, his order of battle, his organizational structure, and his weapons capabilities. Moreover, the kinematic COFM is only accurate when the enemy's tactical techniques and procedures are known in advance so they can be properly portrayed in the model. Anticipating the enemy's force closure rates, his methods for reinforcing and counterattacking, and his propensity for simultaneously attacking deep and close battle targets are but a few of the many information requirements that can significantly alter the kinematic COFM. And, because the enemy may choose not to follow his habitual (doctrinal) methods for force employment, one can never be quite certain that the calculated correlations will be meaningful.

Potential Contradictions. All Soviet operational-tactical decisions are, to some degree, influenced by the mandates of higher headquarters'. As Figure 3 (Chapter 4) demonstrated, the two inputs to the commander's decisionmaking process are mission analysis and the situation estimate; with mission analysis essentially equating to higher headquarters' directives. Frequently, the Soviet commander is directed to destroy a certain percentage of the enemy, to gain a designated space-time objective, ***and*** to preserve a specified percentage of his force. There is distinct potential for contradiction between higher headquarters' guidance and how the commander prefers to employ his forces.

Of course, failing to achieve any of one's assigned tasks equates to failing in mission accomplishment. Sometimes, COFM more confounds than supports the commander in that regard. Its objectivity highlights the numerical incapability to accomplish all assigned tasks using a particular decision variant. If higher headquarters resolves [illegible]mma by providing more forces or by altering the tasks, COFM will have been of benefit. But if the available mission and forces cannot be altered, the commander may feel compelled to alter his preferred decision variant to appease the COFM-generated numbers. By doing so, he will have lost flexibility of action.

Under some circumstances, the Soviet commander may be given assigned tasks that are absolutely irreconcilable with his COFM. The commander's COFM may be so imbalanced that he cannot numerically substantiate any of his decision variants with an acceptable degree of confidence. When faced with such a dilemma, the Soviet commander appears to have several choices. Perhaps he resourcefully develops some means of deception or surprise to tip the COFM in his favor. Perhaps he selects the optimal decision variant, according to the numbers, and hopes for the best. Perhaps he simply ignores the numbers and relies on heuristic judgement in choosing his best course of action. How he resolves such matters is unclear in the Soviet literature.

Uniformity of Application. Despite the Soviets' manifest belief in forecasting and objectivity in military affairs, they have failed to achieve a unified system for correlating forces and means at all three levels of military art. As has been exposed in Chapters 3 and 4, the COFM application is very well developed for operational warfighting and it has a few implications at the tactical level. However, the Soviets have been unable to link operational-tactical COFM to strategic correlations. Cherednichenko's criticisms of modeling expose part of the problem:

> There are an insufficient number of scientific-research establishments in the higher academic institutions of the MOD [ministry of defense]. There is an insufficient number of trained mathematicians to develop mathematical models for the complex military system, particularly at the strategic level. This accounts for the unsatisfactory state of our work with complex mathematical models.[16]

One can imagine the difficulty in developing measures of effectiveness and military-political potentials for the elements of national power that play into any calculation of military-strategic correlations. Objectivity in this arena is difficult if not impossible to achieve. But, it is needed if meaningful planning is to be done. For example, organizing a Soviet TVD (theater of military operations) requires the objective analysis of enemy forces and means that might be employed there. And one should not mistake Tsygichko's proposal for a COFM-related arms control methodology with that required in planning and conducting theater conventional or nuclear warfare. The Soviets have a definite void in objective methodologies for the strategic level of war.

Limited to Conventional Conflicts. The last and most telling deficiency in COFM is that its application is limited, presently, to conventional conflicts.

COFM seeks to assign objective potentials for armament and to aggregate them for conventional force comparisons. Such factors as morale, discipline, and training proficiency can only be dealt with heuristically. Further, it provides no direct consideration of the moral-political influences and the irregular nature of the populace that so often influences combat in low- and mid-intensity conflicts. The Soviet experience in combatting Afghan rebels

[16]M. I. Cherednichenko et al., "On the Question of the Methodology of Mathematically Modeling Operations," *Voyennaia Mysl'*, No. 9 (September) 1988, p. 40.

throughout the 1980's probably reinforced this fact. (The U.S. experience in Vietnam most certainly did.)

There are special problems related to COFM in high-intensity conflicts where weapons of mass destruction may be employed. Nuclear weapons, particularly those of the theater strategic class, can quickly and dramatically alter conventional force correlations beyond recovery. Forecasting the timing and location for the enemy's employment of such weapons borders on soothsaying. Their ranges, the diversity of delivery means, and their powerful yields almost assure a large degree of uncertainty in nuclear COFM evaluations.

If nuclear weapons had not offered enough COFM problems, then chemical weapons would fill the vacuum. Their effects on the form and content of conventional battle (operations) are even less predictable. As with their nuclear counterparts, chemical weapons can be delivered by a variety of means. Furthermore, they are available to almost all modern and developing nations in the world. Their introduction into modern operations is almost assured in certain regions of the world. And their effects can be even more diverse and less localized than those of nuclear weapons. Their influence on the course and outcome of the fight can range from inconsequential to devastating.

The possible use of biological weapons is even more sinister and less predictable than nuclear and chemical weapons. The effects of some biological weapons are impossible to control, much less evaluate. Objective correlations of such weapons are beyond calculation.

SUMMARY

This chapter has shown that COFM offers definite advantages as an objective tool for conventional force comparisons in a high intensity conflict. It eliminates some of the subjectivity in military decisionmaking; freeing the commander for more worthy pre-conflict troop control requirements It affords the Soviet commander a means for optimizing his forces and means in consonance with his assigned tasks. Because COFM is the product of over 100 years of Soviet military-mathematical theory and refinement, it has become highly developed and practiced. It even complements the heuristic side of Soviet military art.

But COFM has also been shown to have certain weaknesses and limitations, chief among which is the simple fact that not every battlefield element can be objectively evaluated. Correlating the morale, discipline, training proficiency, troop control effectiveness, and many other factors cannot be achieved without heuristic judgement. The use of COFM can result in contradictions in the commander's decisionmaking process. Because its accuracy and usefulness require an almost perfect knowledge of enemy forces, COFM calculations will never quite reflect the true status or capabilities of the combatant forces. Model deficiencies will exacerbate that problem for kinematic COFM computations. Last, because COFM cannot presently account for correlations in under other than conventional conditions, its usefulness in many regions of the world and in theater nuclear warfare in Europe is tenuous, at best.

Clearly, though, the Soviet COFM methodology has some distinct merits which ought to attract the attention of Western armies, who typically eschew numerical methods in military decisionmaking. If for no other reason, the Soviet COFM methodology is of interest because its strengths and weaknesses might well expose Soviet capabilities and vulnerabilities that could be important in any future conflict between the superpowers (U.S. and U.S.S.R.) or between their trained surrogates. Chapter 6 will briefly address some of these more important areas for (suggested) further study.

CHAPTER 6

CONCLUSIONS AND AREAS FOR FURTHER RESEARCH

A victory cannot be calculated rather it must be won.[1]

V. M. Bondarenko

CONCLUSIONS

It is most appropriate that COL V. M. Bondarenko's book, ***Automation of Troop Control***, would provide the best single-sentence summary (quotation above) of contemporary Soviet thought on success in battle and operations. COFM has much merit in reducing selected battlefield elements to their quantitative basis. It greatly assists the Soviet commander in optimizing his resources for operational-tactical employment. It even aids the forecasting process, showing fundamental relationships between force correlations and the probability of successful mission accomplishment. What is does ***not*** do, is prescribe the methods by which victory will be won.

This paper has examined the historical Soviet tendency towards use of mathematical methods in military affairs. The early work of such eminent Soviet theorists as Chebyshev, Osipov, and Kolmogorov helped to funnel numerical methods into the Soviet military establishment. Lessons learned from Soviet participation in this century's two world wars, as well as from their own Civil War, reinforced the idea that quantitative tools may be used in solving complex problems in Soviet military science. In fact, Soviet military laws, law-governed patterns, and principles have come to reflect the importance of numbers in determining the course and outcome of modern armed conflict.

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[1]V. M. Bondarenko, *Automation of Troop Control*, (Moscow: Military Publishing House), 1971. Translated by Joint Publications Research Service (JPRS L/8199), 4 January 1979, p. 139.

The author has sought to relate the two essential elements of the COFM methodology-- the derivation of combat potentials and the means by which they may be aggregated into meaningful force correlations. Speshilov's three-phased process for establishing the various correlations were cited as being the most likely method in use, today, in Soviet operational-tactical calculations. Using his technique the Soviets are able to establish three key measures of force superiority: the degree of fire superiority, the degree of (or potential for gaining) air superiority, and the overall strike force of the belligerents. In combination with their various staff models, COFM provides the Soviets with force correlations that are distributed both in time and space.

Chapter 4 detailed the nature of the Soviet decisionmaking process; exposing the natural integration of forecasting and operations research methods into the process. The author determined that COFM is, indeed, a useful mechanism that assists the commander in substantiating decision variants. COFM was found ***not*** to be an impediment in operational-tactical decisionmaking. To the contrary, it was determined to be an expedient means to free the commander from burdensome pre-conflict considerations. It was revealed ***not*** to be prescriptive; more an optimization tool that must be blended with sound military judgement in arriving at decisions.

But despite its inherent merits, COFM must also be viewed in light of its deficiencies and limitations. The objective basis which makes COFM such a valuable instrument in planning and decisionmaking does not account for many qualitative factors that will necessarily influence the course and outcome of any conflict. COFM has been shown to be only as reliable as the models from which its potentials are derived. Dynamic and kinematic COFM calculations are only reliable when Soviet mathematical models properly portray enemy and friendly force dispositions as they change over time. As discussed in Chapter 5, this is extremely difficult (if not impossible) to achieve in stochastic models of sufficiently low resolution for use in operational decisionmaking; much less in the simpler and faster deterministic staff models.

Writing in the July 1987 edition of ***Voyennaia mysl'***, E. A. Evstigneev emphasized that Soviet commanders "don't do battle with numbers, but with minds."[2] Nowhere does Soviet military science infer that COFM must ***dictate*** the mode or means for engaging in armed conflict. Despite the apparent Soviet preoccupation with optimization and objectivity, there remains a strong appreciation for immeasureable factors in operational-tactical decisionmaking. Heuristic judgement is always the final arbiter. The essence of the Soviet commander's art, then, is finding the appropriate balance among quantifiable and unquantifiable factors in arriving at optimal decisions.

SUGGESTED AREAS FOR FURTHER RESEARCH

The serious military practitioner cannot study the Soviets' forms and means of operational-tactical warfighting without developing an admiration for their military-scientific methods. Whether or not one shares the Soviet penchant for objectivity and optimization in military affairs, he cannot help but be impressed with their logical approaches to rational decisionmaking. There is, in fact, a sort of mystique about Soviet objective methods; perpetuated chiefly by the consummate secrecy in which the Soviets conduct their military affairs.

There remain many unknowns in Soviet military art and science: fewer, though, now that selected military publications are being released for Western consumption-- made possible by increasing Soviet permissiveness and the policy of ***glasnost***. The future promises to see further East-West exchanges and even better understanding of Soviet military matters. As that future unfolds, there are several areas that deserve particular attention by Western analysts; many of which are related to the topic of this paper. They are discussed below.

Soviet Combat Potentials. There is little reliable information in the U.S. public domain that gives the numerical figures for Soviet weapons potentials. The Soviets apparently maintain such information as "state secrets." This should not, however, deter the U.S. from attempting to ascertain the Soviet

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[2]E. A. Evstigneev, "Concerning the Question of Mathematical Modeling of Operations," *Voyennaia mysl'*, No. 7 (July) 1987, p. 35.

values. Whether through official military exchange or by parallel (U.S.) modeling, reasonable unclassified numbers should be developed so that the U.S. military can evaluate the COFM methodology in greater detail.

Soviet Models Used for Deriving Combat Potentials. Just as important as the potentials, themselves, are the Soviet mathematical models that are used in generating them. Most basic is the requirement to know whether stochastic or deterministic models are employed in the process. The level of force aggregation (if any) needs to be known. The system parameters that are intrinsically treated should be determined. Their portrayal of (the normally unquantifiable) factors such as troop proficiency, troop control, moral-psychological conditioning of the troops, and enemy tactical techniques and procedures should be checked. Moreover, Soviet modeling techniques for simulating terrain and weather are worthy of examination.

Soviet Formulae for Summing Overall COFM. Assuming that Speshilov's 1981 proposal for grouping combat potentials is the method now in use for Soviet military decisionmaking, there remains the question of how to aggregate the three calculations into "an integrated and collective" correlation. The Soviet method for summing the degree of tank / anti-tank superiority, the degree of fire superiority, and the degree of air superiority into a single sum is still enigmatic. It seems to run counter to Soviet pronouncements about the inappropriateness of correlating dissimilar systems. Resolving this question is central to a complete understanding of the significance that certain (indirect fire, maneuver, and aviation) systems have in shaping Soviet operational-tactical decisions.

State of the Soviet Art in Staff Computers. The last decade has turned up an unexciting amount of Soviet or Warsaw Pact literature on the state of the art in computer modeling. Of particular interest, of course, are the models and algorithms used by Soviet operational-tactical staffs in the field. They have no Western counterparts to this author's knowledge.

Particularly important are the mathematical formulae, algorithms, level of aggregation, and portrayal of random factors inherent in these models. The speed and memory capacity for the various division-, army-, and front-level computer systems should be determined. The outputs of these models are also of interest.

COFM's Potential for Use in Arms Control. Tsygichko's March 1989 proposal for COFM's use in the Vienna (Conventional Defense in Europe) Talks may signal serious Soviet intent to use purely objective methods in reducing conventional arms in Europe. Regardless of Tsygichko's proposal, the U.S. ought to undertake a serious study of the COFM methodology so as not to be embarrassed by or duped into ill-advised agreements. The current capabilities of DoD (Department of Defense) computer technology should easily facilitate such a study. A number of government facilities (and DoD contractors) have the technical capacity and competence to achieve the necessary results.

The author believes that CAA (Concepts Analysis Agency), TRAC-WSMR (Training and Doctrine Command's Research and Analysis Center at White Sands Missile Range), and several of the DoE (Department of Energy) Labs could easily and quickly develop a reasonable COFM-like methodology for U.S. use in the arms control arena. But this could only be made possible if given dedicated (informational) support from such key Army Labs as MICOM (Missile Command), BRL (Ballistics Research Lab), Picatinny Arsenal, USAMSAA (U.S. Army Models and Systems Analysis Agency), and the various weapons systems' Program Managers throughout the Army.

Potential for COFM Integration into U.S. Army Decisionmaking and Planning Processes. Perhaps it is most fitting that this recommendation appears at the end of the thesis. Any reader who has "stayed the course" to this point must have more than a casual interest in COFM or its application; perhaps for developing his own COFM-like methodology. The author wishes to extend his heartiest best wishes in any such undertaking: the U.S. Army currently eschews use of objective methods in military decisionmaking. Changing that in the future will require major impetus.

As outlined in Chapter 5, COFM has definite potential for application at both the operational and tactical levels. It is an efficient force optimizer. It would greatly accelerate the decision process if properly implemented and integrated with U.S. operational art. It would ***not*** necessarily diminish the commander's flexibility of action.

COFM or any similar methodology would certainly improve upon the overly simplistic methodology outlined in the U.S. Army Command and General Staff College's Student Text 100-9 (Command Estimate). It would give commanders a more representative picture of their force capabilities in a variety of battlefield conditions. If coupled with a suitably rugged mini-computer system, the commander could generate pre-conflict estimates of the suitability for each possible course of action-- the degree of mission accomplishment for each variant. When combined with the commander's heuristic judgement, this forecast could greatly assist the commander in shaping the fight-- weighting the main effort, timing the introduction of reserve or supporting forces, synchronizing deep and close fires, etc.

A COFM-like methodology and its associated computer modeling could even ameliorate the problems faced in the Army's combat service support system. Rather than relying solely on antiquated logistics tables, service support planners could use anticipated attrition rates and materiel consumption factors as generated in the operational-tactical model (or by a parallel system that is tied to the battle model). In effect, this would improve the efficiency of pre-battle logistics planning. It offers the potential to shift from the Army's current ***demand-based*** supply system to a more responsive ***push*** system.

Last, the author believes a U.S. Army could develop a COFM methodology that may be broadly applicable in the full spectrum of future U.S. conflicts. With appropriate quantification of selected battlefield elements and reliable intelligence on specific regional conditions, such a methodology could be made interactive-- using subject matter experts in a man-machine interface -- so that weapons and forces as well as regionalized influences can be modeled. The capability exists, today, for developing such a model. Sophisticated training models are already in use. The Army simply needs to sponsor the implementation of a parallel system for operational-tactical decisionmaking.

APPENDIX 1

APPENDIX 1

GLOSSARY OF TERMS

Algorithm: An aggregate of rules, the following of which inevitably must lead to the solving of one or another problem; the rule for processing information in accordance with the set goal. [From: N. A. Lomov, *The Revolution in Military Affairs*, (Moscow: Military Publishing House), 1973, p. 177.]

Correlation of Forces and Means: An objective indicator of combat might/power of opposing sides which makes it possible to determine the degree of superiority of one side over another. This is determined by means of comparing the quantitative and qualitative characteristics of subunits, units and formations and the armaments of one's own troops (forces) and those of the enemy. [From: *Dictionary of Military Terms*, (Moscow: Military Publishing House), 1988.]

Cybernetics: A science that studies the most general laws of control in systems of any nature and complexity. [From: N. A. Lomov, *The Revolution in Military Affairs*, (Moscow: Military Publishing House), 1973, p.165.]

Forecasting: A research process, as a result of which we obtain probability data about the future state of the object being forecast; may be quantitative and qualitative in content. [From: Yu. V. Chuyev and Yu. B. Mikhaylov, *Forecasting in Military Affairs*, (Moscow: Military Publishing House), 1975, p. 8.]

Foresight (*predvidenie*): The process of gaining knowledge of possible changes in the area of military affairs and the determination of the prospects for their future development. Knowledge of the objective patterns and mechanisms of war and the dialectical-materialist analysis of events that take place in a specific historical situation constitutes the basis of scientific foresight. The following are elements of scientific foresight: prediction/forecasting, planning, and management (management decisions). The complexity of foresight in the military realm is determined by the operation of various random or chance factors, to a greater extent than in any other field. [This complexity is further determined by] the insufficiency of essential information on the enemy. The ability to successfully engage in foresight is a most important quality of military cadres. [From: S. F. Akhromeev, "Foresight," *Military Encyclopedic Dictionary*, (Moscow: Military Publishing House), 1986. p. 583.]

Laws of Armed Conflict: The deep internal, essential, necessary, stable, repetitious ties and relationships among phenomena of military operations or their attributes which are manifested on battlefields in the course of armed conflict itself. [From: V. Ye. Savkin, *The Basic Principles of Operational Art and Tactics*, (Moscow: Military Publishing House), 1972, p. 56.]

Laws of War: The essential, necessary, and stable ties or relationships of phenomena and processes of war; ties and relationships among peoples and armies of countries participating in war and their governments, policies, and goals of war; ties and relationships between war, the course of armed conflict, and state of the rear of states and their economic, moral policies, and military potential. [From: V. Ye. Savkin, *The Basic Principles of Operational Art and Tactics*, (Moscow: Military Publishing House), 1972, p. 55.]

Military Art (Voennoe iskusstvo): The theory and practice of the preparation and conduct of military activities on land, sea, and air. The theory of military art is part of military science. Soviet military art includes military strategy, operational art, and tactics-- [components which] are closely interrelated. The state of military art depends on the level of the development of manufacturing, the means of military combat and the nature of the social system. The development of military art is influenced by the historic and national peculiarities of the country, its geographic situation and other factors. [From: A. M. Plekhov, "Military Art," *Dictionary of Military Terminology*, (Moscow: Military Publishing House), 1988, p. 51.]

Military Forecasting: The study of the military-political situation, the pattern of war in the future, the prospects of developing strategy, operational art, and tactics, the qualitative and quantitative composition of the means of armed conflict (one's own and the enemy's), the prospects for development of the potential of the war economy in the future, and also the forecasting of the enemy's strategic and tactical plans. [From: Yu. V. Chuyev and Yu. B. Mikhaylov, *Forecasting in Military Affairs*, (Moscow: Military Publishing House), 1975, p. 14.]

Military Science: A system of knowledge about the nature, essence, and content of armed conflict, and about the forces, means, and methods of waging combat operations with armed forces and their thorough support. It includes the study of the objective laws of armed conflict; the development of questions of the theory of military art; the questions of development and preparation of the armed forces, and of their military-technological outfitting; and the analysis of military-historical experience. [From: V. Ye. Savkin, *The Basic Principles of Operational Art and Tactics*, (Moscow: Military Publishing House), 1972, p. 152.]

Military Strategy (*Strategiya voennaya*): That part of the higher sphere of military art encompassing the theory and practice of the preparation of the country and its armed forces for war, with the aim of planning and conducting strategic operations and war. Military strategy is tightly joined with the military doctrine of the state and is guided by its propositions in the resolution of practical tasks. Soviet military strategy is determined by the politics of the Communist party of the Soviet Union and the Soviet government which serve the cause of peace and safety of mankind and the interest of defense of the gains of socialism from the encroachment of any aggression. With respect to the other component parts of the military art-- operational art and tactics-- military strategy occupies the most important position and is unified for all forms of the military services. [From: A. M. Plekhov, "Military Strategy," *Dictionary of Military Terminology*, (Moscow: Military Publishing House), 1988, p. 282.]

Operational Art: The theory and practice of preparing and conducting operations by large strategic formations of the armed forces. Taking its cue from strategy, operational art is concerned with the nature of modern operations, with the laws, principles, and methods of their preparation and conduct, with the organization, possibilities, and principles of the use of large operational formations, with the problems of operational support, and with the principles of the command and control of troops in operations and their rear support. [From: V. G. Reznichenko, *Taktika*, (Moscow: Military Publishing House), 1987, p. 2.]

Operational-Tactical Forecasting: Forecasting the future means and methods of conducting combat operations in various theaters of war (based on strategic forecasting data), and with practicable principles of the operational employment (application) of various existing and prospective systems and individual models of weapons and equipment. [From: Yu. V. Chuyev and Yu. B. Mikhaylov, *Forecasting in Military Affairs*, (Moscow: Military Publishing House), 1975, p. 17.]

Operations Research: The special science concerned with rational methods for organizing goal-directed human activity. [From: Ye. S. Venttsel', *Introduction to Operations Research*, (Moscow: Soviet Radio Publishing House), 1964, p. 1.]

Prediction: The art of judging the future state of an object, based on the subjective "weighing" of a large number of qualitative and quantitative factors. [From: Yu. V. Chuyev and Yu. B. Mikhaylov, *Forecasting in Military Affairs*, (Moscow: Military Publishing House), 1975, p. 8.]

Principles: The fundamental, initial theses of any teaching or the fundamental ideas and rules in accordance with which practical activity takes place in a specific field; the fundamental ideas by which people are guided in a particular field of their practical endeavor. [From: V. Ye. Savkin, *The Basic Principles of Operational Art and Tactics*, (Moscow: Military Publishing House), 1972, p. 119.]

Principles of Military Art: The basic ideas and most important recommendations for the organization and conduct of a battle, an operation, or a war as a whole. [From: V. Ye. Savkin, *The Basic Principles of Operational Art and Tactics*, (Moscow: Military Publishing House), 1972, p.119.]

Principles of Troop Control: The general leading ideas and rules for controlling the troops. Among them are: sole responsibility and collectivism, centralization, initiative and independence, foresight and constant knowledge of the situation, firmness and flexibility of control, continuity, concealment, and high proficiency. [From: N. A. Lomov, *The Revolution in Military Affairs*, (Moscow: Military Publishing House), 1973, p.168.]

Strategy: The highest area of military art. It consists in the questions of using the armed forces as a whole or large groupings of different types of armed forces in the course of the war in theaters of military operations for achieving victory over the enemy, as well as questions of preparing the armed forces for carrying out combat missions. It is also an area of activity for the bodies of superior military command to prepare the armed forces in peacetime and for leadership over them in the course of armed combat. [From: N. A. Lomov, *The Revolution in Military Affairs*, (Moscow: Military Publishing House), 1973, p. 134.]

(Military) Strategic Forecasting: Forecasting associated with the character and means of conducting future wars that may occur, the forecasting of the military objectives, missions, actual plans, and overall composition of the armed forces of the individual countries and coalitions. [From: Yu. V. Chuyev and Yu. B. Mikhaylov, *Forecasting in Military Affairs*, (Moscow: Military Publishing House), 1975, p. 17.]

Systems Analysis: A method for preparing well-founded solutions to complex problems of a political, military, social, economic, and technical nature, necessitated by the uncertainty brought about by the presence of factors not amenable to qualitative evaluation. [From: *Soviet Military Encyclopedia*, (Moscow: Military Publishing House), 1979, VII, p. 363.]

Tactics: The theory and practice of the preparation and conduct of battle by subunits, units and formations of different combat arms, services of troops (forces), and special troops of the Armed Forces; concerns itself with the laws of combined-arms combat and generates recommendations on the preparation and conduct of such combat. [From: V. G. Reznichenko, *Taktika*, (Moscow: Military Publishing House), 1987, p. 2.]

APPENDIX 2

APPENDIX 2

SOVIET MILITARY CATEGORIES OF LAWS, LAW-GOVERNED PATTERNS & PRINCIPLES

I. LAWS OF WAR.*

A. The course and outcome of a war depend on its political content.**

B. The course and outcome of a war depend on the correlation of moral-political and psychological capabilities of the people and the armies of the combatants.**

C. The course and outcome of a war waged with unlimited employment of all means of conflict depend primarily on the correlation of available, strictly military forces of the combatants at the beginning of the war, especially in nuclear weapons and means of delivery.

D. The course and outcome of war depend on the correlation of military potentials of the combatants.

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*[From: V. Ye. Savkin, *The Basic Principles of Operational Art and Tactics*, (Moscow: Military Publishing House), 1972, pp. 89-92.]

**The first two Laws of War are thought to have a direct effect on literally all principles of military art and are their most objective basis.

II. LAWS OF ARMED STRUGGLE.*

A. The dependence of armed struggle on the military-political objectives of the war.

B. The dependence of the forms and ways of conducting armed struggle on the quantity and the quality of weapons, [both] combat and special technology.

C. The dependence of the effectiveness of the combat operations to the objectives (tasks) and conditions of the tactical situation.

D. The dependence of the course and outcome of armed struggle on the correlation of forces and means of the parties.

E. The dependence of the course and outcome of armed struggle on the moral-political and psychological condition of the personnel of the troops.

F. The dependence of the course and outcome of armed struggle on the level of training of commands, staff, and troops.

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*[From: P. K. Altukhov, *Basis of the Theory of Troop Control*, (Moscow: Military Publishing House), 1984, p. 28.]

**Altukhov infers that other Laws of Armed Struggle exist, although they are not given in his book.

III. LAWS OF MILITARY CONTROL.*

A. The law of the dependence of organization forms and methods of control on the structure of the Armed Forces, the material-technical base and conditions of control.

B. The law of the unity of the organizational-methodological bases on all levels of control.

C. The law of the preservation of proportion and the optimal correlation of all elements of the system of control.

D. The law of the compatibility of technical means and the systems of control of co-ordinating [sic] and co-operating [sic] troops.

E. The law of the unity and the co-ordination [sic] of criteria of effectiveness used in the processes of troop control.

F. The law of the conformity of required and disposable time with the accomplishment of tasks of control.

G. The law of the dependence of the effectiveness of the accomplishment of tasks on the volume of the information which is given.

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*[From: P. K. Altukhov, *Basis of the Theory of Troop Control*, (Moscow: Military Publishing House), 1984, p. 30.]

IV. LAW-GOVERNED PATTERNS OF ARMED CONFLICT.*

A. The dependence of the course and outcome of armed combat on the war's political aims.

B. The dependence of the decisiveness and intensity of combat operations on the moral-psychological factor.

C. The dependence of the course and outcome on the economic capabilities of the warring parties.

D. The dependence of the course and outcome of armed combat between two parties on [their] nuclear-missile weaponry.

E. The dependence of the forms and methods for conducting armed combat on weapons and combat potential.

F. The dependence of success on the presence of superiority over the enemy in forces and means at decisive places and times.

G. The dependence of success on the combined efforts of all services of the armed forces and branches of service.

H. The dependence of success on the correct combination of attack and defense.

I. The dependence of force operation in the resolution of operational and tactical tasks on strategic goals.

J. The dependence of the course and outcome of armed combat on anticipation in deployment and strike delivery.

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*[From: K. V. Tarakanov, *Mathematics and Armed Combat*, (Moscow: Military Publishing House), 1974. Translated by U.S. Air Force (FTD-ID(RS)T-0577-79), (AD-B043718), 15 August 1979, pp. 19-20.]

V. PRINCIPLES OF MILITARY ART.*

A. High combat readiness, surprise, decisiveness, activeness, and retaining the initiative.

B. The complete use of all means and methods for achieving victory.

C. The coordinated employment and close interaction of the field forces and formations of the Armed Services and the branches of troops.

D. The decisive concentration of main efforts on the major sectors at the crucial moment.

E. The simultaneous defeat of the enemy to the entire depth of its configuration.

F. Bold maneuvering and building up of force.

G. Consideration and full employment of the morale-political factor.

H. Firm and continuous command.

I. The prompt replacement of reserves.

J. Complete support for battle tasks.

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*[From: M. M. Kir'yan, *The History of Military Art*, (Moscow: Military Publishing House), 1986, p. 305.]

**Kir'yan states that these are the most important of the current Principles, inferring that the Soviets subscribe to others as well.

VI. PRINCIPLES OF OPERATIONAL ART AND TACTICS.*

A. Mobility and high tempo of combat operations.

B. Concentration of main efforts and creation of the necessary superiority in men and weapons over the enemy at the decisive place at the decisive time (concentration of efforts).

C. Surprise.

D. Combat activeness.

E. Preservation of combat effectiveness of friendly troops.

F. Conformity of the goal of the operation or battle to conditions of the actual situation.

G. Interworking.

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*[From: V. Ye. Savkin, *The Basic Principles of Operational Art and Tactics*, (Moscow: Military Publishing House), 1972, pp. 167-277.]

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